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ABSTRACT

Over 60 energy education activities comprise this manual for junior high school teachers. These lessons are experience-oriented and emphasize questioning, the use of reference materials, data collection, and discussion. For every grade level, three activities dealing with each of seven recurring conceptual schemes are provided. Lesson plans include directions for introducing and developing the activity, suggested extensions of the learning experience, and a listing of the lesson's concept and objective.
(WE)

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DRAFT

ENERGY
and
MY ENVIRONMENT

7 - 9 TEACHERS' GUIDE

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ENERGY AND MY ENVIRONMENT
TEACHERS' GUIDE - GRADES 7 - 9

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Funded by a grant from the U.S. Department of Energy, this public document was printed at a cost of \$2.00 per copy. Its purpose is to provide the teachers of Florida with a guide to assist in teaching energy and energy conservation in grades seven, eight and nine.

FOREWORD

This teachers' guide is the second of a series entitled ENERGY AND MY ENVIRONMENT. The first volume was a Teachers' Guide for Kindergarten through Grade Six and a third will be written for teachers of subjects in Grades Ten through Twelve. Final publication of the complete series should occur in February, 1980.

After participating in many curriculum development and educational planning projects, the editors recognized one element which permeates those which were most successful. That element is the establishment of major ideas which serve as recurring themes throughout the child's educational experiences. This publication is designed to integrate key energy and energy conservation ideas in just such a manner.

The State of Florida was most fortunate indeed in obtaining the services of Dr. Matthew J. Brennan as the author of this series of teachers' guides. His work as editor on the PEOPLE AND THEIR ENVIRONMENT series established him as one of the founders and principal practitioners of this cognitive theme approach.

These materials are designed to provide the flexibility which any good teacher demands, yet provide the recurring themes which may well be essential if the lessons are to have any lasting impact on the student. These materials can play an important role in the development of a citizenry which thinks and acts on a basis of factual knowledge of key energy concepts, yet also possess an understanding of the great national and international web of energy relationships and interdependencies important for the citizen of today and essential for the citizens of the future.

The Editors

Introduction - To The Teacher

Is there an "energy crisis"? There has always been an energy crisis, as humans struggled to survive on planet Earth. Now we face a new energy crisis--a crisis related to the future supply of fossil fuels on which our civilization depends. This new energy crisis provides unlimited possibilities for student activities which will help children learn about the earth, and how the use of energy has shaped civilizations of the past and present, and how it will determine the civilizations of the future.

Through their use of energy, humans have radically changed the environment. Now we must face the consequences of these changes, not only on the environment, but on all of life, including our own; on our societies; our economies; on the air we breathe and the water we drink; on the lifestyles we lead; on the quality of the environment; and on the lives of the animals with whom we share the earth. The changes were made by people. The problems they have created can only be solved by people--indeed, by people who wish to solve them.

So we have reached the "crisis". The fossil fuels which gave us unlimited supplies of cheap energy are being rapidly depleted. The time for decision has arrived. How will we answer? Whether we solve these problems will depend on how clearly they are recognized. It is hoped that the activities in this guide will help students understand the scientific, social, and aesthetic alternatives which must be considered.

The activities have been organized around the seven major conceptual schemes relating to energy, with a Unit at each grade level for each one of the conceptual schemes. In addition, there is a lesson concept for each lesson to help the teacher coordinate the activities with other areas of the curriculum. Each lesson is designed to suggest some activity, with the emphasis on "suggest", because students will be free to interpret each activity suggestion as they will. The editors have "suggested" subject area applications for each lesson.

You will have many ideas for variation and improvement of the lessons suggested. Let the Governor's Energy Office know of these so that future revisions of this guide will better serve the needs of teachers in this rapidly changing area of education.

ENERGY POLICY FOR FLORIDA

WHEREAS, energy availability strongly impacts upon every aspect of human existence and the conservation of energy resources is essential to the health, safety, and welfare of the people of this state and to the well-being of the state economy; and

WHEREAS, Florida is particularly dependent upon other states and nations to supply its energy needs; and

WHEREAS, the majority of Florida's energy requirements are obtained from petroleum and natural gas, and supply of these fuels are subject to interruption; and

WHEREAS, wasteful, inefficient, uneconomic, and unnecessary use of energy will result in a serious depletion of energy resources and represents a potential threat to preserving the health, safety, and welfare of the people of Florida; and

WHEREAS, alternative sources of energy are years from being fully developed and there is a pressing need to accelerate research and development of these sources; and

WHEREAS, energy conservation represents a meaningful, immediate and appropriate state response to the energy problem by eliminating waste and inefficiency and increasing economic productivity, by reducing the depletion of our domestic energy resources which, in turn, increases economic flexibility of the people of Florida, and by decreasing the pressure to develop marginally efficient methods of energy production and thereby reducing the flow of capital from the non-energy sections of the economy and avoiding serious impacts on our environment.

NOW, THEREFORE, BE IT RESOLVED

IT SHALL BE THE POLICY OF THE STATE OF FLORIDA TO:

1. Develop and promote the effective use of energy in the State and to discourage all forms of energy waste.
2. Play a leading role in developing and instituting energy management programs aimed at promoting energy conservation; to include energy considerations in all planning; and to utilize and manage effectively energy resources used within state agencies.
3. Encourage local governments to include energy considerations in all planning, to support their work in promoting energy management programs, and to include the full participation of citizens in the development and implementation of energy programs.
4. Consider in its decisions the energy needs of each economic sector, including residential, industrial, commercial, agricultural, and governmental uses.
5. Promote energy education and the public dissemination of information on energy and its environmental, economic, and social impacts.

6. Encourage the research, development, demonstration, and application of alternative energy resources, particularly renewable energy resources.
7. Consider in its decision making the social, economic and environmental impacts of energy-related activities so that detrimental effects of these activities are understood and minimized.
8. Develop and maintain energy emergency preparedness plans to minimize the effects within Florida of an energy shortage.

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Energy is held in various forms of matter.

Energy is required to make something move.

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SEVENTH GRADE, UNIT I

(Math, Social Studies, Art)

UNIT I

1. Title: Where Has All The Fuel Gone?

Concept: Energy is the ability to do work.

Objective: To discover the relationship between energy and work

Introducing the lesson:

1. Ask: "How many of your parents have had difficulty getting gasoline for their cars?"
2. Make a list of the class members and the occasions when their parents were unable to get gasoline.

Developing the lesson:

1. Have the students keep a record for a week of all the gasoline stations that have lines of cars; closed days; "out-of-gas" signs, etc.
2. Do a similar survey to locate closed stations and the brand name of the gasoline they formerly sold.
3. Ask: "What kinds of stations seem to be most affected by the gasoline shortages?"
4. When your parents get gasoline, survey the station owners to find out:
 - a. where does their gasoline come from?
 - b. how much do they get each month? (their allocation)
 - c. who decides this amount?
 - d. how does their allocation compare with the year before?
 - e. do they own their station or operate it for an oil company?
 - f. would they favor some kind of a rationing plan?

Extending the lesson:

1. Draw a picture of you and your parents waiting in a line to get gasoline for your car.
2. Ask: "How do the values of people affect their behavior in the gasoline station line?" (are they patient, rude, greedy, thankful to be getting gasoline, other?)
3. Draw a picture which would illustrate your lifestyle if gasoline use was limited to getting to work and shopping.
4. Discuss your picture and compare it with those of other members of the class.
5. Ask: "Were your pictures realistic?"
6. Ask: "How would your new lifestyle affect you and your community in terms of:
 - a. community activities?"
 - b. shopping?"
 - c. recreation?"
 - d. out-of-community activities?"
 - e. other energy uses?"
7. Start a class word list of energy terms - an energy vocabulary. (see appendix)

UNIT I

2. Title: Energy and Matter

Concept: Energy is held in various forms of matter.

Objective: To discover the relationship between energy and matter

Introducing the lesson:

1. Hold up a nut, a candy bar, a battery, a candle, a piece of wood or coal, a balloon full of air.
2. Ask: "What do all of these things have in common?"
(all contain stored energy in various forms)

Developing the lesson:

1. Ask: "What are the three forms of matter in which energy can be stored?" (solid, liquid, gas)
2. Ask the students to give some examples of each.
(Coal, gasoline, natural gas)
3. Ask: "What do we call these forms of matter which contain stored energy?" (fuels)
4. For each of the items used to introduce the lesson, investigate how the energy in it can be used. (let the balloon go and the escaping air will move it; pass electricity through the battery; burn the candle, wood, or coal; eat the candy bar and nut)

Extending the lesson:

1. Ask: "What kinds of matter contain energy which cannot be released or used by burning or passing electricity through it?" (radioactive matter such as uranium ores which radiate their energy into the environment)
2. Ask: "What kinds of matter do not contain energy?" (Inert matter - gases, and minerals which are not radioactive)
3. Draw a picture of yourself enjoying your favorite form of matter containing energy.
4. Describe your picture in any way except with words.
5. Investigate the amount of energy in different forms of matter. (calorie chart)
6. Make up a calorie chart for the items shown by the class in their pictures of favorite forms of matter.
7. Add to the class energy vocabulary.

SEVENTH GRADE, UNIT I

(Physical Education, Social
Studies, Music, Science)

UNIT I

3. Title: Move Like Something

Concept: Energy is required to make something move.

Objective: To discover the relationship between energy and movement.

Introducing the lesson:

1. Take the class to the auditorium or gymnasium.
2. Ask each student to decide on their favorite use of energy and to design a movement which shows this use of energy. (be ready to provide music)

Developing the lesson:

1. Ask for volunteers to demonstrate their favorite use of energy for movement.
2. Have the class decide what use of energy each movement illustrates.
3. Some students will need encouragement. Ask: "How many have designed a movement similar to (a name)'s?"
4. Ask: "Who designed a different movement from any we have seen?"
5. Ask: "Is there anyone else?" (some students may still not want to perform. That's O.K. Perhaps they could show the class in a different way)

Extending the lesson:

1. Gather the students who designed similar movements and have them develop a dance which includes all the movements used by the members of the group. (for example, a football dance; a dance dance; a birdwatcher's dance)
2. Compare the movements used in terms of the amount of energy used to do them.
3. Devise a system for measuring energy use without measuring. (getting tired, sweating, faster breathing)
4. Ask: "Why would these devices indicate greater use of energy?" (breathe faster to get more oxygen to release energy; sweat indicates excess heat produced)
5. Ask: "Could you do a movement which would not require any use of energy?" (no)

SEVENTH GRADE, UNIT I

6. Ask: "Are we using energy when we are doing 'nothing'?"
(yes - staying alive, warm, in good health, organs functioning, etc.)
7. Ask: "Can we do nothing?" (when we do nothing, we will no longer be alive. Energy is needed for any body action or function, even those we cannot control)
8. Add to the class energy vocabulary.

UNIT II

1. Title: What's In A Barrel Of Oil?

Concept: Energy comes in many forms.

Objective: To discover the relationship between energy and fuels

Introducing the lesson:

1. Ask: "Is diesel fuel the answer to the nation's gasoline shortage?" (evidently not, as we shall see, even though diesel fuel is usually cheaper and diesel engines are more energy efficient in terms of mileage per gallon and maintenance.)
2. Examine and discuss the diagram which shows what our oil refineries get from a barrel of crude oil. (next page)

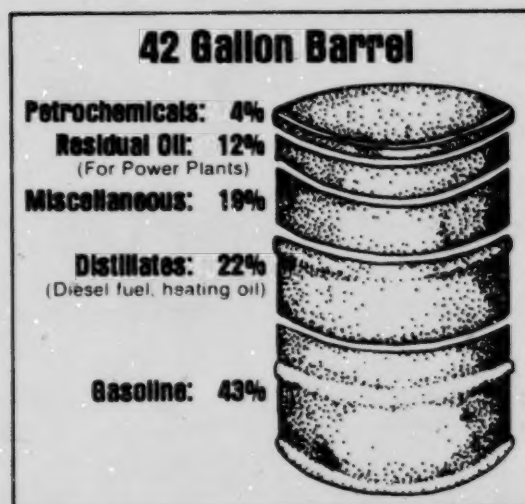
Developing the lesson:

1. Compare the amount of gasoline obtained with the amount of distillates. (43% to 22%)
2. Ask: "What other factors influence the amount of diesel fuel available for automobiles?" (heating oil is also made from distillates and is used in homes and factories; when more heating oil is needed, there will be less diesel fuel.)
3. Ask: "What factors influence the amount of diesel fuel available for diesel automobiles?" (also used by trucks, trains, and farm equipment, all of which will have priority over automobiles in the event of a shortage.)
4. Investigate the other products that are made from oil.
5. Ask: "What is "Miscellaneous"?" (jet fuel, kerosene, asphalt, lubricants)
6. Petrochemicals use about 4% of our crude oil. Investigate the use of petrochemicals in making fertilizer, plastics, and fibers.
7. Ask the students to survey a shopping center and list the products for sale there. Discuss what the stores would have to sell if oil was no longer available for synthetic materials.

Extending the lesson:

1. Describe your life without plastics or synthetic fibers.
2. Ask the students to determine their priorities for use of a. crude oil; b. gasoline; c. distillates.

3. Investigate how the student priorities compare with the priorities established by state and federal governments. (for example, the federal government has given priority to farm production)
4. Investigate reaction of truckers to shortages and costs of diesel fuel.
5. Ask: "Is diesel fuel the answer to the problems of the automobile owner?"
6. Ask: "If electric power plants use only residual (left over) fuel, why convert them to coal?" (In the future, refineries will have to use every drop of crude; there will be no "residuals" to use)
7. Ask: "Is the news that we can have either gasoline or heating oil somewhat misleading?" Discuss. (Remember that the diagram barrel used in this lesson is meant to show what we now get from a barrel of crude oil. If necessary, refineries could get all heating oil or all petrochemicals, etc.)
8. Add to the class energy vocabulary.



UNIT II

2. Title: Hydrogen As A Fuel

Concept: Energy comes in many forms.

Objective: To discover the relationship between energy and fuels

Introducing the lesson:

1. In his book, THE MOVING AMERICAN, author George W. Pierson wrote: "One of the essential freedoms of American Democracy is the freedom to move." He believes that the famous dictum of Descartes: "I think, therefore, I am", has been changed in American philosophy to: "I move, therefore, I am alive". Ask the students to comment on this statement.
2. Scientists say that the energy to move us about, as well as to produce our electricity, could be obtained by using hydrogen as a fuel. Ask: "How can we get hydrogen?"

Developing the lesson:

1. Investigate the use of wind power to produce hydrogen.
2. Investigate the use of hydrogen as a fuel in internal combustion engines. (see Wilson Clark reference)
3. Ask: "Why are so many people afraid of hydrogen?" (the explosion and burning of the German dirigible Hindenburg at Lakehurst, New Jersey over 40 years ago is still remembered when hydrogen is discussed as a fuel)
4. Ask: "Are the fears of hydrogen valid?" (hydrogen can be dangerous, as is any fuel gas, forming an explosive mixture with air, burning easily, with intense heat. That is why it is a good fuel! However, hydrogen is so light that it diffuses rapidly into the air after a leak or spill, and actually poses less of a hazard than gasoline)
5. Investigate other methods of producing hydrogen using electricity. (by power plants during "off-peak" hours; by ocean thermal temperature differences, as in the Gulf Stream, etc.)

Extending the lesson:

1. Ask: "What about air pollution from use of hydrogen as a fuel?" (hydrogen combines with oxygen in burning, producing only water as its waste; the only pollutant in automobile engines would be small amounts of nitrogen oxides)

SEVENTH GRADE, UNIT II

2. Investigate the use of hydrogen to produce electricity locally in fuel cells. (see Clark reference)
3. Read in Jules Verne's famous 1847 novel, THE MYSTERIOUS ISLAND, about an engineer who predicted the use of hydrogen as a fuel when coal and other fuels are all gone.
4. Investigate other potential synthetic substitutes for petroleum products as fuels. (acetylene, ammonia, hydrazine, methane and methanol)
5. Discuss other ways in which hydrogen can be used by people to conserve scarce oil supplies.
6. Discuss the interest of the oil and power companies in the use of hydrogen as a fuel.
7. Compare this interest with that of an environmentalist.
8. Add to the class energy vocabulary.

UNIT II

3. Title: Nature Stores Energy

Concept: Energy comes in many forms.

Objective: To discover the relationship between energy and the fuels and foods produced by plants

Introducing the lesson:

1. Ask: "What is the most important chemical reaction on earth?" (the reaction in which the radiant energy of the sun is absorbed by the chlorophyll in a green plant, producing the chemical energy which sustains life on the earth)
2. Review the process of photosynthesis. (breaks down the water and carbon dioxide taken in by a green plant to form sugar--a composite of carbon, hydrogen, and oxygen--and pure oxygen, thus capturing the sun's energy and storing it)

Developing the lesson:

1. Investigate the storage of energy in carbohydrates and ATP (adenosine triphosphate) in living cells.
2. Ask: "How do animals use this stored energy?" (to do muscular work, keep warm, to generate nerve impulses, to make proteins and other molecules for building new cells)
3. Review the kinds of plant foods we eat and determine the plant part which stores it. (obviously, the part which stores most of the energy is the part we eat)
4. Ask: "Are there any plant parts that are not used for the storage of energy?" (no, they will all burn)

Extending the lesson:

1. Investigate the relationship between energy storage and size of seeds in a plant. (plants that store their food in stems or roots have tiny seeds compared to corn or beans, which store their food in seeds)
2. Design and illustrate a dream plant which stores food in every part.
3. Ask: "Which part of your dream plant would you prefer to eat?"
4. Ask: "How would you decide?"

SEVENTH GRADE, UNIT II

5. Ask: "What energy stored in plants is not available as food to people?" (cellulose: humans do not have the digestive enzymes necessary to break down the cellulose in wood, grass, cotton, seed coats, etc.)
6. Add to the class energy vocabulary list.

UNIT III

1. Title: Burning

Concept: Energy is released from matter by burning.

Objective: To discover the relationship between energy and matter

Introducing the lesson:

1. Ask the students to list all the kinds of burning they can. (fire; sensation of the skin in the wind; giving light, as a candle; injury caused by heat, extreme cold, chemicals, electricity, or lightning; burning of food in an animal body)
2. Ask: "What do all the examples have in common?" (burning--the combination of an organic substance with oxygen or oxidation)

Developing the lesson:

1. Draw pictures or diagram to show the oxidation of fuels to produce heat.
2. Design a demonstration to show that energy can be changed from one form to another.
3. Have the students combine two or more of their demonstrations to show a new energy change.
4. Show how people use energy changes.
5. Demonstrate how matter could be either a food or a fuel.
6. Give some examples of matter that are food for one kind of animal and fuel for another animal.

Extending the lesson:

1. Invent a device to measure heat given off by burning.
2. Measure some heat with your device.
3. For each fuel or food conversion to energy by burning, list the by-products formed.
4. Create a way to show how heat and joy are interrelated.
5. Show this relationship in a drawing.
6. Go on to the next lesson to learn one of the possible effects of burning fuels by people.
7. Add to the class energy vocabulary.

SEVENTH GRADE, UNIT III

(Science, Geography, Social
Studies)

UNIT III

2. Title: "Greenhouse Effect"

Concept: Energy can be changed from one form to another.

Objective: To discover the relationship between different forms of energy

Introducing the lesson:

1. Ask the class to list the possible effects of increased burning of fuels on the earth environment. (addition of heat, increased carbon dioxide, air pollution, etc.)
2. Investigate the operation of a greenhouse. (glass lets in solar short-wave radiation, but prevents the passage of long-wave infra-red radiation (heat) out of the greenhouse. A closed automobile sitting in the Florida sun is another good example.)

Developing the lesson:

1. Scientists know that carbon dioxide acts in the atmosphere like the glass in a greenhouse, keeping in the heat from solar radiation. Ask: "What effect could this have on the earth's climate?" (raise the temperature)
2. Ask: "How could the increased burning of fuels contribute to the 'greenhouse effect'?" (an increase of both heat and the carbon dioxide which holds it on earth)
3. Construct model greenhouses and measure the effect on inside air temperatures after exposure to the sun.
4. Measure the increase in temperature in a school bus or automobile sitting in the sun for one hour; two hours; all morning.
5. Investigate the predictions of scientists regarding the effects of the heat which will be released in the burning of the earth's remaining fossil fuels. (some estimate a 2 degree Fahrenheit increase in the earth's temperature. Other scientists believe that the earth may grow colder as a result of the large amounts of smoke, soot, etc. released into the atmosphere, which may reflect sunlight away from the earth, thus cooling the planet.)

Extending the lesson:

1. If the earth's temperature raises 2 degrees Fahrenheit, scientists estimate that melting of the Antarctic ice-cap would raise the level of the oceans (sea level) by 200 feet. Draw a map of the "new" United States, showing areas under 200 feet covered with water. (without its coastal cities--and Florida)

2. Discuss other possible effects of increased energy use:
 - a. transportation of oil (oil spills)
 - b. automobiles (air pollution)
 - c. urbanization (loss of vegetation - carbon dioxide sink)
 - d. agriculture (loss of forests - carbon dioxide sinks)
3. Investigate plans to utilize the increased "waste" heat for power production.
4. Add to the class energy vocabulary list.

UNIT III

3. Title: Move Molecules

Concept: Energy can be changed from one form to another.

Objective: To discover the relationship between energy and the movement of molecules

Introducing the lesson:

1. Ask the students to cover their eyes while you:
 - a. spray a perfumed aerosol.
 - b. peel an orange.
 - c. release some favorite odor.
2. Ask them to identify the odors.
3. Ask: "How did the smells get from the front of the room to your nose?" (molecules moved in the air)

Developing the lesson:

1. Ask the students to design a demonstration (or use one which occurs in the community) to demonstrate how molecules move in:
 - a. water (boil it)
 - b. in honey or catsup (pour it)
 - c. a fluorescent tube (light it)
 - d. a wire (bend it back and forth, or send electricity through it)
 - e. an iron nail (magnetize it)
 - f. ice (put an ice cube in water)
2. Ask: "What happened in each case?" (matter was heated)
3. Investigate how people change molecules from one form to another in:
 - a. liquified natural gas.
 - b. gasification of coal to natural gas. (synthetic gas)
 - c. liquefaction of coal to oil
 - d. getting oil from oil shale or tar sands.

4. Ask: "How do these processes make it easier to move fuels from one place to another?" (gas compressed; oils easier to move after rock, sand, and impurities are removed.)
5. Consider the environmental effects of each of the fuel conversion processes.

Extending the lesson:

1. Describe an environment in which all fuels were first converted to clean-burning gas. (remember the great amounts of water needed for conversion processes)
2. Ask: "What problems would still exist in the 'clean gas' world?" (increased carbon dioxide; environmental damage in coal and shale mining, etc.)
3. Relate the kinds of energy used in our community to its transportation, storage, and utilization.
4. Visit an airport and investigate the kinds of fuels used by various aircraft.
5. Investigate the environmental problems of unwanted molecules in energy use:
 - a. sulphur in coal, oil, and gas (acid rain)
 - b. nuclear radiation
 - c. heat pollution (power plant cooling waters)
 - d. waste disposal
 - e. auto emissions
6. Discuss how these and other energy problems have become political issues.
7. Add to the class energy vocabulary.

SEVENTH GRADE, UNIT IV

(Science, Social Studies,
American History)

UNIT IV

1. Title: Man And The Sun

Concept: Radiant energy comes from the sun.

Objective: To discover the relationship between the energy of the sun and life on earth

Introducing the lesson:

1. Ask the students to complete the following phrase: "Solar radiation is....." (consider its nature, appearance, effects, capture by plants, use by animals and man)
2. Discuss the student responses and make a list of possible topics for further discussion and investigation.

Developing the lesson:

1. Follow up on ideas for activities from the discussion above.
2. Investigate the solar architecture of the Pueblo Indians, design for heating, cooling, ventilation, illumination, and integration with natural cycles of season and climate.
3. Ask: "How does this solar architecture correspond to animal structures--bee hives, ant hills, animal burrows, bird's nests, etc.?"
4. Ask: "Why has modern man lost the art of solar architecture in the high energy society?" (air conditioning has replaced mental skills and ingenuity in dealing with nature)

Extending the lesson:

1. Investigate the suggestions for siting and orientation of houses, buildings, and even cities with regard to the sun, prevailing winds, and other climatic and geographic features by the ancient Roman architect Vitruvius in the time of the Emperor Augustus. (see Wilson Clark)
2. Investigate the design and construction of the buildings of the Seminole and Miccosukee Indians of Florida.
3. Ask: "Why were early American barns painted red?" ("Paint" was skim milk mixed with iron rust coloring and lime, which absorbed sunlight--a "solar heating device")
4. Predict the future for buildings like the World Trade Center twin towers, with over 100 stories, and no insulation or windows that will open. Discuss how a building like this could have been designed and constructed. (energy was so cheap; there was no reason to be concerned about the costs of heating, cooling, or lighting)

SEVENTH GRADE, UNIT IV

5. Investigate modern solar architecture in the U.S.A. to determine how it is like - or unlike - ancient solar architecture.
6. Add to the class energy vocabulary list.

UNIT IV

2. Title: A Clothes "Pole"

Concept: Solar energy is used to evaporate water.

Objective: To discover the relationship between energy and the evaporation of water

Introducing the lesson:

1. Survey the class to determine use of appliances for washing and drying clothes. Ask: "How many of you are wearing clothes that were washed and dried without using any appliances?"
2. Determine what articles of clothing are most apt to be washed by hand and hung up to dry.
3. Now make a separate survey for washing and drying.

Developing the lesson:

1. Ask: "How many have an outdoor clothesline or dryer?"
2. The U. S. Department of Energy estimates that the average owner of a clothes dryer uses 1000 kilowatt-hours of electric power per year. Calculate how many kilowatt-hours of electric power are used by the homes of class members, using the DOE's average rate.
3. How much would this cost at \$4.00 per kilowatt-hour?
4. From local weather records, determine the number of days on which clothes could have been dried outdoors in your community last year.
5. How much energy could be saved if all the people in your community hung their clothes out to dry? (number of homes times 1000 kilowatt-hours per year)
6. Conduct a "clothes pole" (poll) of your neighborhood to find out how many homes have dryers and how many have outdoor clotheslines.
7. Ask: "Is there any evidence that the number of outside clotheslines is changing."

Extending the lesson:

1. Survey radio and TV advertisements for detergents. How many emphasize the "clean, fresh smell of the outdoors" which is lost by using an electric or gas dryer?
2. Investigate why Monday was always washday.

3. Discuss the relationship between the increase in use of clothes dryers, air pollution, and urbanization.
4. Investigate the water pollution problems associated with the use of detergents.
5. Ask: "Should the use of clothes dryers be banned to save electricity or gas?" Discuss the pros and cons.
6. Ask: "Is there another appliance that your family would rather give up than your clothes dryer?"
7. List the appliances in the order in which the members of the class would give them up in the event of a serious energy shortage.
8. Add to the class energy vocabulary list.

UNIT IV

3. Title: Moving Air

Concept: The sun's energy affects the atmosphere of the earth.

Objective: To discover the relationship between solar energy
and moving air

Introducing the lesson:

1. Complete the following sentence: "Wind is....."
2. Write the words used by the students on the chalkboard as fast as you can, no matter how unlikely they may sound to you.
3. From the class list of words, develop a list of opposite words which can be used to describe moving air. (for example, hot-cold; good-bad; fickle-steady; reliable-unpredictable; gentle-violent; etc.)

Developing the lesson:

1. Ask: "What do most of the words tell us about what wind is?" (moving air)
2. Investigate the atmosphere around the earth as a giant heat machine (engine) moved by solar radiation. (the rays of the sun, stronger near the Equator than in the polar regions, cause tropical air to warm and rise, while cooler polar air moves in to replace it.)
3. Discuss the effect of the earth's rotation on this north-south flow of heated air. (air moving to the north - a south wind - is deflected toward the east = a SW wind; air moving to the south - a north wind - is deflected toward the west = a NE (trade) wind)
4. Ask: "What other factors influence the movement of air?" (local atmospheric conditions - high and low pressure systems; obstructions - mountains or high buildings; and type of surface - asphalt, land, or water, which influence local heating and cooling)
5. Discuss how a sea breeze follows this general pattern of uneven heating of the earth's surface. (air over land heats and rises; colder air over water flows in to take its place)

Extending the lesson:

1. Investigate the historical importance of the wind as a source of energy for people's use. (moved ships; pumped water; milled grain; etc.)

2. Investigate the windmills invented by Marcellus Jacobs of Fort Myers, Florida to produce electricity with a wind generator.
3. Move like the kind of wind which represents each of the words used to describe it at the beginning of this lesson.
4. Draw a picture of your favorite wind, and a wind you are afraid of.
5. Ask: "How do airplanes use the wind?" (take-off; landing; flight; jet stream; tail winds)
6. Investigate how wind and other weather records are kept.
7. See the wind graphically on the TV satellite weather report each day.
8. Add to the class energy vocabulary list.

SEVENTH GRADE, UNIT V

(Home Economics, Science,
History, English)

UNIT V

1. Title: Who Needs Appliances?

Concept: People use energy to do their work.

Objective: To discover the relationship between people's use of energy and the appliances that do their work

Introducing the lesson:

1. Ask: "Who needs appliances?"
2. Make a class survey to develop a list of appliances that are used by your students.
3. Rank the appliances on the class list according to the number of students who use them.

Developing the lesson:

1. Have the students rank the class appliances in order of most importance to them in their daily lives.
2. Determine what, if any, appliances the students would be willing to give up in an electricity "crisis".
3. Investigate the contribution of Georg Simon Ohm (Ohm's Law) to man's application of electricity to the needs of civilization. (discovered the relationship between the resistance to the flow of electricity in a wire and its transformation into heat and light, as in an electric toaster or heater)
4. Ask: "How did Thomas Edison use Ohm's Law to develop the electric light bulb?"
5. Trace the influence of man's use of appliances on:
 - a. industry
 - b. social concentration
 - c. education
 - d. power distribution
 - e. life-styles
 - f. recreation
 - g. entertainment
 - h. others you can think of.
6. Find advertisements promoting greater use of appliances.

7. Look for changes in industry ads as a result of the energy crisis.

Extending the lesson:

1. Write a rebuttal for the appliance ads you found.
2. Perform the part of a salesperson representing an energy-conscious appliance company.
3. Draw a picture of yourself in a world without appliances.
4. Describe your new world.
5. Write a paragraph describing your last weekend, leaving a blank each time you would write an energy word.
6. Keep a record of each electric appliance you use during a week and what you used the appliance for. (for example, toaster - toast bread)
7. Compare your week's use of appliances with a list for someone from another culture or period (pioneer, Indian)
8. Examine the effect of the development of an appliance on an industry. Try to find an industry for each kind of appliance on the class list. (for example, the effect of the toaster on the bread industry; of washer-dryer on laundromat)
9. Ask: "Who needs appliances?"
10. Add to the class energy vocabulary list.

SEVENTH GRADE, UNIT V

(Science, Home Economics,
Social Studies)

UNIT V

2. Title: Synthetics

Concept: People use oil to produce synthetic materials.

Objective: To discover the relationship between synthetic materials and the oil chemicals and energy used to make them

Introducing the lesson:

1. Ask: "If you took off all the clothes you are wearing which were made from synthetic materials or fibers, what would you be wearing?" (possibly not much more than part of a pair of sneakers and a smile)
2. Make a class list of the synthetics being worn.
3. Ask: "Do we live in an age of synthetics?"

Developing the lesson:

1. Investigate the use of crude oil by the petro-chemical industry. (use about 5% of oil supply to produce the chemicals needed for the manufacture of synthetics)
2. Take a class field trip to a shopping mall to survey the store windows for synthetic products. (do not go into any of the stores)
3. At the end of the field trip, make a list of the synthetic products seen by members of the class.
4. Divide the class list of synthetic products into the following categories, those which:
 - a. make life easier
 - b. make life more comfortable
 - c. make life more enjoyable
 - d. make life more wasteful
 - e. make life more efficient.
5. Determine how many stores would have things to sell if there were no synthetic products.
6. Investigate the substitutes for these and other natural products--wood, leather, cotton, wool, oil.

Extending the lesson:

1. Check your own list of synthetic possessions.

2. Discuss how synthetic products have changed the form and amount of packaging by industries (use the yellow pages to get a list of industries affected)
3. Discuss the pros and cons of modern packaging.
4. For each item on the class list of synthetic products, determine the natural materials that were replaced and the effects on the industries that market the natural materials. (effect of nylon on cotton, for example)
5. Synthetics have replaced natural materials in many manufacturing processes. Investigate the effects of this replacement on people and sections of the nation. (for example, effect on the South of changes in textile manufacturing)
6. Make a mural showing life before the invention of synthetic products.
7. Devise a synthetics-energy conservation program for:
 - a. yourself
 - b. your school
 - c. your home
 - d. your community.
8. Ask: "Should we save the 5% of crude oil used by the petrochemical industry?" (consider your discussion in relation to the number of stores dependent on synthetics)
9. Add to the class energy vocabulary list.

SEVENTH GRADE, UNIT V
(Social Studies, Math,
English, History)

UNIT V

3. Title: Gasoline Rationing - Why Not?

Concept: People need energy for transportation and commerce.

Objective: To discover the relationship between the lives of people and their use of energy

Introducing the lesson:

1. Presidents, governors, and legislators and government officials at every level keep saying: "There will be no rationing of gasoline....it doesn't work...it isn't fair...it would cost too much to develop and operate a rationing plan...etc." Ask: "Why not have a rationing plan for gasoline if supplies are as limited as our officials say?"
2. Collect stories and pictures of lines of cars at gasoline stations.
3. Write a newspaper article about lines at gasoline stations and reactions of people waiting.

Developing the lesson:

1. Survey gasoline supplies in your community and how they compare with supplies available a year ago.
2. Investigate previous attempts to ration gasoline. (World War II, and in 1979)
3. Interview someone who can remember rationing during World War II.
4. Discuss the elements of various rationing plans.
5. Describe the effects of a rationing plan under which each licensed driver received coupons which could be used or sold; used but not transferable.
6. Using all possible elements, devise a rationing plan on which the class could agree. (Probably impossible, which will be a good illustration of why politicians do not want to be involved in developing a plan)
7. On the basis of your discussion, ask if the students think any plan could be entirely fair.
8. Evaluate the odd-even license number system of selling gasoline used in California, Florida, and other states.
9. Investigate modifications in the odd-even plan.
10. Ask: "What is a 'black market'?"

Extending the lesson:

1. Ask: "How about closing gasoline stations on weekends?"
2. Investigate the effects of gasoline rationing on the tourist industry and the economy of Florida.
3. Discuss whether Florida as a tourist state should get a larger allotment in any national allocation plan.
4. Calculate the amount of gasoline needed to keep all the automobiles in the U. S. with full tanks of gasoline. (There are 110 million in the U.S.; 5 million in Florida. Tanks hold from 15-25 gallons.) Compare this amount with the normal amount of gasoline in the gas tanks of America's automobiles. (About double, since normally tanks average about half full, with some full, some nearly empty, some in between)
5. Ask: "How have the media (radio and TV) contributed to the shortage?" (scared people into keeping tanks full)
6. Write a paper describing how your lifestyle would be affected during a period of gasoline rationing or shortage.
7. Investigate the dangers of carrying gasoline in cans in the trunks of automobiles.
8. Devise a system to beat the rationing plan the class developed.
9. Add to the class energy vocabulary list.

SEVENTH GRADE, UNIT VI
(Social Studies, English)

UNIT VI

1. Title: Obituary To A "Gas Guzzler"

Concept: Energy supplies are limited.

Objective: To discover the relationship between energy supplies and automobile engine efficiency

Introducing the lesson:

1. Read this to your class: A television news story stated that "An association of owners of Rolls-Royce automobiles is lobbying for special consideration for their gasoline needs in the event of a gasoline shortage. Their reason: they are unique, and their 5 mile-per-gallon 'gas guzzlers' are an important element of the good life of America and should be maintained." The owners also expressed their willingness to pay a penalty tax of \$500 to \$1000 to offset their high use of energy.

Developing the lesson:

1. Ask: "Do you think the large, luxury car owners have a valid argument?"
2. Discuss the pros and cons of their case.
3. Ask: "Do you believe a penalty of \$500-\$1000 would make up for their excessive use of gasoline?" (their cars cost up to \$75,000)
4. Check with your local big-car dealers to determine any changes in their automobiles since the oil crisis of 1973 in:
 - a. weight of automobiles
 - b. gasoline efficiency in miles-per-gallon
 - c. sales volume
 - d. advertising (efficiency vs. luxury)
5. Survey small-car dealers to determine any change in the numbers of big-car owners who have traded in their "gas guzzlers" for a small automobile.
6. Investigate the availability of diesel engine automobiles.
7. Write an obituary to a "gas guzzler".

Extending the lesson:

1. Design an epitaph to a "gas guzzler".
2. Ask: "What will take the place of the large luxury car in

the dreams of people?"

3. Write a poem on the new dream.
4. Write a class skit showing the last owner of a "gas guzzler" trying to buy gasoline.
5. Have the class observe a moment of silence for the last "gas guzzler".
6. Compare the worst "gas guzzling" automobile with a yacht or private airplane.
7. Ask: "Is a compact car 'saving gas' driving down a highway as its bumper sticker says?"
8. Play a game filling in the blank with one or two word endings. Student with most words wins. (For example: An automobile is saving energy when it is _____ (parked, tuned-up, coasting, turned off, etc.)
9. Add to the class energy vocabulary list.

UNIT VI

2. Title: Energy Ads

Concept: People make demands on limited energy supplies.

Objective: To discover the relationship between energy shortage and advertisements for business products

Introducing the lesson:

1. Collect energy industry advertisements from newspapers and magazines and discuss their messages to the public.
2. Classify the advertising into categories. (price rise justification; "what a good job of conservation we're doing"; cost of regulation; "survival" ads arguing against divestiture of competing energy sources, etc.)

Developing the lesson:

1. Discuss the validity of each of the categories of advertisements you collected.
2. Ask: "Are the arguments of the energy companies persuasive?"
3. Look for ads that "turn you off"; "turn you on".
4. Discuss the reasons for the "turn off" or "turn on".
5. Collect ads from other businesses or industries that contain an energy message. (low mileage cars, etc.)
6. Look for ads which indicate a change in approach because of the energy shortage. (large cars emphasizing mileage and smaller size instead of luxury, etc.)
7. Ask: "Why would an electric power advertisement call for conservation and decreased use of electricity?" (power companies can no longer meet the unlimited demands of people for electricity)
8. Create a "billboard" advertisement for your school which stresses conservation of electricity.

Extending the lesson:

1. Design a cover for a new magazine to be called EN-ER-GEE.
2. Write an advertisement to appeal to new subscribers for your new magazine.
3. Design and produce a TV commercial.
4. Write a radio commercial.

5. Write the first energy editorial for EN-ER-GEE.
6. Write a "letter to the editor" of EN-ER-GEE supporting or criticizing the first editorial.
7. Divide the class into several editorial boards which will suggest topics for inclusion in the magazine.
8. Design the magazine on the basis of their recommendations.
9. Write an article for EN-ER-GEE which describes to your future son or daughter the present energy situation and what you are doing about it.
10. Illustrate your article.
11. Write your child's reaction to your letter.
12. Add to the class energy vocabulary list.

SEVENTH GRADE, UNIT VI
(Social Studies)

UNIT VI

3. Title: My Community Sees The "Crisis"

Concept: Limited energy affects the lives of people.

Objective: To discover the relationship between energy shortage and the life of a community

Introducing the lesson:

1. Ask: "Who is to blame for the energy shortage?"
2. Discuss the students answers and the reasons for their opinions. (it will soon become obvious that there is no one answer. No one is to blame. Everyone is to blame. We are all, in some way, responsible. As Pogo says, "We have met the enemy and he is us".)

Developing the lesson:

1. Make a list of the people or events the students thought were to blame for the energy shortage. (President, Congress, Secretary of Energy, Iranian revolution, Mid-East situation, increasing population, limits to oil supply, greedy people, wasteful useage, too many cars, etc.)
2. Investigate each of the items on the list.
3. Ask: "Why is it so difficult to get a national energy policy?" (most people do not really believe there is an energy shortage; many diverse groups and interests to satisfy; too politically dangerous)
4. Survey community reaction to the energy "crisis". Ask:
 - a. "Is there an energy 'crisis'?"
 - b. "Do you have a personal commitment to energy conservation?"
 - c. "What should government be doing about the energy shortage?"
 - d. "Who is to blame for the energy shortage?"

Extending the lesson:

1. Plan an energy conservation program for your:
 - a. classroom
 - b. school
 - c. home
 - d. community

2. Make posters for your program.
3. Develop a slide or other media production to illustrate your program's development and progress.
4. Start a personal energy conservation program.
5. Describe your personal program to the class. Include:
 - a. a list of energy wasters you own or use
 - b. how you decided
 - c. which ones you don't really need to use
 - d. how you can do without the ones you really don't need
 - e. ways you can cut down on your use of the energy wasters
6. Create a design for an energy T-shirt.
7. Make up some energy conservation slogans.
8. Collect bumper stickers with energy slogans.
9. Add to the class energy vocabulary list.

SEVENTH GRADE, UNIT VII

(Home Economics, Social Studies,
Science, Geography)

UNIT VII

1. Title: I Depend On Others

Concept: Living things are interdependent.

Objective: To discover the relationship between people in the supply and use of energy

Introducing the lesson:

1. Ask: "What did you eat for breakfast today that you grew yourself?" Make a list of the replies. (fruit, bacon, sausage, etc.)
2. Ask: "What are you wearing that you made yourself?" (even a homemade dress is made from materials made by other people) Make a list.

Developing the lesson:

1. Make a class list of food items eaten for breakfast,
2. Construct a food energy chain from each breakfast item back to the green plant which originally captured the sun's energy and stored it.
3. Now construct an energy chain which shows all the people and energy involved in getting the breakfast items from their place of origin to your tables.
4. Make a similar list of clothes and materials worn by the class. (dress - cotton; shirt - polyester; etc.)
5. Trace on a map the routes followed by these clothes or materials from their country (or state) of origin to Florida (or you).
6. Construct an energy chain which shows the use of energy in the various steps between the fiber and the clothes you are wearing. (be sure to include origin, manufacture, packaging, transportation, marketing, etc.)

Extending the lesson:

1. Trace the routes followed by the energy materials used to make the clothing from their country of origin to Florida.
2. Show how you are dependent on organisms that lived long ago. (in addition to most of our fuels, synthetic materials and fibers are made from fossil fuel oil formed from the bodies of plants and animals that lived millions of years ago)
3. Investigate sources and supplies of foods and fuels that are limited because of national and international politics.

SEVENTH GRADE, UNIT VII

4. Draw a picture of yourself eating your favorite breakfast while wearing your favorite garment.
5. Ask: "Why is sugar added to so many breakfast foods?" (provides additional calories; is heavier and cheaper than cereals and is subsidized)
6. Ask: "How do you depend on others for your energy?"
7. Ask: "What others depend on you for their energy?" (work in supermarket, gas station, farm, etc.)
8. Ask: "What responsibility do you have for continued supplies of food and fiber?" (energy saved makes more available)
9. Add to the class energy vocabulary list.

UNIT VII

2. Title: Population And Energy Supply

Concept: Increasing population affects the amount of energy available to each person.

Objective: To discover the relationship between energy supply and numbers of people

Introducing the lesson:

1. Take the class outside to a quiet area of the school grounds. With a ball of string, lay out a circle about 20 feet in diameter. Then use more string to divide the circle into eight smaller sections of different sizes. The circle now represents the earth divided into several nations of different sizes.
2. Place half of the students in the countries to represent the population. Be sure to have at least one small country with three people and one large country with only one.
3. Let the rest of the class stand around the circle.
4. Show the class a bag of dried beans, preferably small and dark so they are harder to see. Say: "These beans represent all the fossil fuel in the world".
5. Scatter the beans (modules of energy) unevenly around the "earth". Be sure to put only a few beans in the smallest country and many beans in the largest country.

Developing the lesson:

1. To start the game, ask each person to pick up one energy module. (if you want the game to go faster, pick up two)
2. Pick up one more energy module.
3. Add one person to each country to represent an increase in population.
4. Pick up another energy module.
5. Continue the search for energy modules, with an occasional addition to the population, until the whole class is in the circle.
6. When a population in a country cannot find any more energy modules, they must leave the circle.
7. Continue the game until only a few countries have energy modules left, or interest lags.
8. Ask: "Which countries end up with energy?"

Extending the lesson:

1. Ask the students to compare the game with the world situation.
2. Ask the students to compare the countries in the game with real nations. (is the small nation like Japan?)
3. Discuss how the real world differs from the game. (in the real world, many resources are involved, not just oil, so an energy-poor nation may have another resource to trade for energy)
4. Discuss the actions of the students in the game:
 - a. What did they observe?
 - b. Did people get anxious, greedy, selfish?
 - c. Did people reach over borders?
 - d. Did people share?
5. Ask: "How do you account for these behaviors?"
6. Investigate the following nations to determine: size; population; energy reserves; major resources to trade: Venezuela, Canada, U.S.A., Saudi Arabia, Iran, Nigeria, Japan, Mexico.
7. Discuss the effects of increasing world population and increasing demand for limited energy supplies. Consider:
 - a. economic effects
 - b. political effects
 - c. effect on standard of living.
8. Add to the class energy vocabulary list.

UNIT VII

3. Title: "Who - Me?"

Concept: Each individual has a responsibility to conserve energy.

Objective: To discover the relationship between the "energy crisis and me"

Introducing the lesson:

1. Ask: "Are you part of the energy problem?"
2. Ask: "What have you done today to conserve our scarce energy supplies?"
3. Make a list of the things students did to conserve energy during the past week.

Developing the lesson:

1. Ask the students who feel that they are not part of the energy problem to defend their position. Have a recorder keep a record of the discussion.
2. Ask the students to record for one week:
 - a. number of times they opened the refrigerator
 - b. asked their parents to drive them somewhere
 - c. rode a bike instead of asking for a ride in a car
 - d. drank a cold drink
 - e. used ice cubes
 - f. took a hot shower
 - g. sat in an over-cooled room
 - h. watched TV
 - i. add another item.
3. Ask again: "Are you part of the energy problem?"

Extending the lesson:

1. Discuss how the energy shortage has changed the lives of members of the class and their families.
2. Investigate the effects on the school, the community, the state, the nation.
3. Discuss changes in the lifestyles of people and how they might be affected by continued energy shortages. (we will still live

the "good life" even if we conserve energy)

4. Compare lifestyles of people in the 1950's and today.
(in the U.S., we used 50% less energy per person in
the 1950's)
5. Add to the class energy vocabulary list.

EIGHTH GRADE, UNIT I
(Science, History)

UNIT I

1. Title: Solar Energy For Power

Concept: Energy is the ability to do work.

Objective: To discover the relationship between energy and power

Introducing the lesson:

1. The day before starting this lesson, ask each student to bring in a small mirror and a magnifying glass.
2. Take the students outside to the school yard. Have them try to focus the rays of the sun on a small piece of paper placed on a sidewalk or other bare area. (bring a small container of water to wet the area around the paper) Students should have no trouble burning a hole in the paper. They have used solar energy to do work.
3. Next, set up a piece of paper vertically between the sun and the class. Ask the students to use their mirrors to focus the sun's rays on the piece of paper from their position. (they will have to move forward or back to do this)
4. After they have focused their mirrors, have them try to focus on a central spot to burn a hole in the paper.
5. Have each student measure and record the distance from the mirror to the paper. (are they all the same distance?)

Developing the lesson:

1. According to the Greek historian Galen, the Greek scientist Archimedes used solar reflecting mirrors (bronze shields) to set fire to the Roman fleet besieging the City of Syracuse in 212 B.C. by focusing the sun's rays on their black sails. On the basis of their own experience, do the students think this was possible?
2. Read about how this might have been done in the book, "Power For The People", by Allen and Marjorie Meinel.
3. Investigate the construction and operation of a solar oven.
4. Build one and use it.
5. Ask one of the students to investigate and report on the solar system engine built by the French scientist Augustin Mouchet in the 1860's.
6. Do the same for the work of the Swedish-American John Ericson in the development of solar engines.
7. Investigate the research of Frank Shuman in Pennsylvania and his development of the Sun Power Company in 1908.

EIGHTH GRADE, UNIT I

8. Compare the operation of the Sun Furnace in the French Pyreness (Felix Trombe) to the experience with mirrors the students had at the beginning of this lesson.
9. Investigate the use of solar power for desalting water.

Extending the lesson:

1. Ask: "How did the discovery of oil in Pennsylvania affect the development of solar power?" (oil was a much cheaper source of power, so research was almost halted until 1973)
2. Ask: "How have 'the times' made water desalinization important?" (water shortages and pollution)
3. Investigate how the solar power research of Dr. Robert Goddard led to his invention of the rocket engine.
4. Investigate the development of solar water heaters in Florida.
5. Design a solar still.
6. Use it to get a drink of water.
7. Draw a picture of yourself operating a solar still.
8. Start a class energy vocabulary list. (there is one in the back of this teacher's guide, but it will be better to develop your own as your lessons occur)

UNIT I

2. Title: Stored Energy And Work

Concept: Energy is the ability to do work.

Objective: To discover the relationship between potential and kinetic energy in water power

Introducing the lesson:

1. On a rainy day, take the class outside the school. Find a gully or gutter (it does not have to be a big one) and have the students watch how the water carries particles of soil and debris as it flows.
2. Dam up the water channel, creating a reservoir behind the dam.
3. Note how the water in the reservoir continually tries to flow out, requiring additional dams around the edges of the reservoir.
4. When the reservoir is full, ask one of the students to make a tiny hole below the surface of the water in the dam. Watch what happens.

Developing the lesson:

1. Ask the students why the water poured through the broken dam. (stored energy released to provide active (kinetic) energy of flowing water)
2. Ask: "Why is the stored energy in the reservoir of water called 'potential' energy?" (potential means capable of action due to its position)
3. Investigate the production of hydro-electric power by a release of stored water from a reservoir through a turbine generator.
4. Discuss the limitations on amounts of hydro-electric power available in the world. (limited - potential reservoir sites like the Grand Canyon are protected by their location in National Parks or Monuments; all reservoirs will eventually fill with sediments carried by the river which has been dammed. Remember the soil particles and debris carried into the class "reservoir" at the beginning of the lesson)
5. Investigate the double use of the potential energy of stored water in the "pumped storage" concept of hydro-electric power development. (during periods of low demand for power, electricity is used to pump water to a higher reservoir. Then, when added amounts of electricity are needed to meet demand, this water from the higher reservoir is released to flow down through turbine generators to produce more electricity)

6. Investigate the renewed interest in an age-old source of power--the small dam for local power to run mills and generate electricity.

Extending the lesson:

1. Investigate other ways in which energy can be stored. (nuclear; geothermal; fossil fuel; wood; food)
2. Find an example of energy that cannot be stored. (electricity)
3. Investigate the problems of big-dam reservoirs like Aswan, Egypt, in terms of changed environments.
4. Investigate environmental objections to big dams in the U.S. (cover prime farmland; cut off passage of migratory fish; possible earthquakes as a result of great weight of stored water; loss of wildlife habitat; loss of water through evaporation; flood threat of broken dam)
5. Investigate tragic floods in Idaho, West Virginia, and other places.
6. Add to the class energy word list.

UNIT I

3. Title: We Change Environments

Concept: Use of energy by people has changed the environment.

Objective: To discover the relationship between the use of energy and its effect on the environment

Introducing the lesson:

1. Go outside the school and ask the students to look for and list any changes in their environment as a result of people's use of energy.
2. Make a class list.
3. Divide the class list of changes into the following categories:
 - a. search for energy
 - b. energy supply to school, home or community
 - c. energy use
 - d. waste disposal.

Developing the lesson:

1. Find evidence of ways people change environments in each of the categories above.
2. Investigate the environmental effects of production of:
 - a. coal (strip-mining; acid wastes)
 - b. oil (drilling; spills; offshore platforms)
 - c. electricity (air; water; thermal pollution)
 - d. nuclear power (radiation; radioactive waste disposal; heat)
3. Investigate the environment effects of the use of:
 - a. coal (air pollution by sulphur oxides; acid rain; soot)
 - b. oil (auto emissions; sulphur oxides)
 - c. electricity (power lines)
 - d. nuclear electric power (same as electricity)
4. Investigate the environmental problems of various energy supply sources:
 - a. Alaskan North Slope (need pipeline for delivery)

- b. North Sea (deep water; rough seas; weather)
 - c. Gulf of Mexico (relatively few; storms; spills)
 - d. Big Cypress (destruction of wilderness)
 - e. Appalachia (ravaged lands from strip mining)
 - f. Shale formations in western U. S. (water supply; waste disposal)
5. Predict the effect of these environmental problems on future energy supplies.

Extending the lesson:

1. Investigate laws and regulations which are designed to minimize the environmental effects of energy supply, use, and disposal of wastes.
2. Investigate the impact of the Three-Mile nuclear power plant accident in Pennsylvania on the future of nuclear power production.
3. Draw a picture of your community without power lines.
4. Discuss the reasons for the seeming reluctance of industry and government officials to exert a major effort to develop solar electric power. (most power would be produced locally, not in giant plants)
5. Add to the class energy vocabulary list.

EIGHTH GRADE, UNIT II

(Science, Art, Social Studies,
Language Arts)

UNIT II

1. Title: Electricity Is....

Concept: Electricity is a form of energy.

Objective: To discover the relationship between electricity and the fuels used to produce it

Introducing the lesson:

1. Divide the class into groups of four students.
2. Give each group a large (4X6 foot) piece of butcher paper and an assortment of colored marking pens (or assign each group to a section of the chalkboard).
3. Ask each student to use a one-foot square corner of their group paper, and, without using words, show how they would complete the sentence: "Electricity is...."

Developing the lesson:

1. After the students have completed their "sentences", ask each group to discuss how they would finish the sentence: "Electricity could be" until they have agreed on what they would say. Then...
2. Working as a team, ask each group to illustrate their completed "could be" sentence using the center of their paper. They may use words this time, but only to supplement their illustration.
3. Ask each group to report to the class on their illustration, first describing what electricity is, and then what it could be.
4. After each group presentation, allow the class to discuss the presentation or ask questions.
5. Find ideas that seem to appear in all the presentations.
6. Discuss the possibilities of realization of their predictions of what electricity could be.
7. List the major uses of electricity in your school and community and predict how each of these would be affected by a shortage of electric power.

Extending the lesson:

1. Write a paragraph describing how you finished the sentences on electricity.
2. Do the same exercise for coal, gas, wood, atomic power.

3. Trace the historical influence of electricity on:
 - a. industry
 - b. social concentration
 - c. education
 - d. power distribution
 - e. recreation
 - f. entertainment
 - g. life-styles of people.
4. Describe a world without electricity.
5. Draw a picture of what your life would be without electricity.
6. Describe your picture to the class.
7. Invent a form of power to replace electricity.
8. Write a paragraph describing a day in your life, leaving a blank each time you used an energy word.
9. Who had the most blanks? the least?
10. Add to the class energy word list.

EIGHTH GRADE, UNIT II

(Science, Social Studies,
History)

UNIT II

2. Title: Wind Energy

Concept: Wind is a form of indirect solar energy.

Objective: To discover the relationship between the movement of air and the energy it produces

Introducing the lesson:

1. Before you do this lesson, you might want to review lesson 3 in Unit I, Grade 7.
2. Ask the class if there is anyone who has experienced a hurricane or severe storm.
3. Ask them to describe the storms, emphasizing the force of the wind, the pressure it exerts, the work it can do.
4. Collect pictures and news accounts of hurricanes that have passed over Florida. Make a bulletin board display.

Developing the lesson:

1. Ask: "What is the principal 'fuel' for the earth's heat engine?" (water vapor in the atmosphere, holding latent energy which is transferred to the atmosphere when water is alternately evaporated and condensed in the water cycle. Wind is the most evident form of this energy)
2. Investigate the classification of winds by the U.S. Weather Bureau.
3. Distinguish between energy winds and prevalent winds. (prevalent winds - common, up to 5 days a week, 5-15 miles per hour; energy winds - storm winds, average 2 days per week, 10-25 miles per hour; for example, the "Northeaster" or Southwester")
4. Ask the students to investigate the direction and average speed of the prevailing and energy winds in their area.
5. Describe, or move like a: zephyr; breeze; blast; gust; gale; storm; tornado; hurricane.
6. Investigate the contribution of Sir Francis Beaufort to measuring wind speed.
7. Ask: "What would be the most important characteristics to consider in deciding whether to set up a windmill in your area?" (prevailing wind; regularity; best height)
8. Ask: "Would our area be satisfactory?" (scientists say that winds needed for power production should fall between Beaufort force 3 and 6 (gentle to strong breeze); higher winds may be destructive)

EIGHTH GRADE, UNIT II

9. Investigate the use of sailing ships throughout history.
10. Investigate the use of wind to pump water throughout history.
11. Find out how "sails" made windmills more efficient.

Extending the lesson:

1. Investigate the renewed interest in wind power in the U.S.
2. Investigate the plans for use of windmills for the production of electricity and hydrogen for fuel by Dr. William Heronomus of the University of Massachusetts.
3. Move like your favorite wind.
4. Describe the production of electricity by wind generators.
5. Design and construct a windmill.
6. Add to the class energy vocabulary list.

UNIT II

3. Title: Earth Heat

Concept: The core of the earth is a hot, molten mass.

Objective: To discover the relationship between the earth's heat and man's need for new energy sources

Introducing the lesson:

1. Ask: "What is the earth like 40 miles below the surface on which we live?" (dense, molten rock at temperatures as high as 3300 degrees Fahrenheit)
2. Ask: "How can people use this heat energy as a source of energy at the surface?" (lava flows through cracks to surface--volcano; hot gasses heat underground water to the boiling point causing hot springs and geysers)

Developing the lesson:

1. Investigate the history of volcanos like Kakatoa, Mount Ranier, Kilauea Iki, Vesuvius, Popocatepetl.
2. Ask: "How can a volcanic mountain like Mount Erebus in Antarctica exist?" (earth's heat near surface, even in Antarctica; many volcanos are snow-capped)
3. Trace home heating with water from hot springs in Iceland.
4. Investigate the use of geothermal energy in the U.S.
5. Describe the three forms of geothermal energy. (dry steam; wet steam and water; hot, dry rocks)
6. Show on a map the hot springs and geysers of the world.
7. Investigate the operation of a geothermal power plant.

Extending the lesson:

1. Trace the history of people's use of geothermal energy.
2. Investigate the environmental effects of the use of geothermal energy for power production. (blowouts of salt-laden water; sulphur dioxide air pollution; water pollution; unknown but suspected earthquake effects; excessive cost with present technology)
3. Show pictures of geysers and hot springs.
4. List the famous hot springs of the U. S.
5. Investigate political constraints against use of geothermal energy in the U.S. (most of sources are on Federal lands, many protected in National Parks; much controversy over

EIGHTH GRADE, UNIT II

Federal leasing and possible ownership by same companies that now control other power sources)

6. Describe your feelings when you first saw a picture of the geyser "Old Faithful".
7. Take a vicarious field trip to Yellowstone National Park via picture and story.
8. Draw a picture showing your favorite scene there.
9. Ask: "Why are hot springs supposed to have therapeutic value for those who bathe in them?" (the same salts and other minerals in the waters which are a concern for people worried about water and air pollution have a therapeutic value for bathers)
10. Add to the class energy word list.

EIGHTH GRADE, UNIT III

(Agriculture, History,
Social Studies)

UNIT III

1. Title: Energy On The Farm

Concept: People use energy to supply their food and fiber.

Objective: To discover the relationship between energy use and agricultural production

Introducing the lesson:

1. In the U. S., we now use 6 times more calories of energy to produce our food than the food contains. Compare the farm of 100 years ago with a modern farm in terms of energy use.
2. Collect pictures of past and present farming methods and compare the apparent use of energy.

Developing the lesson:

1. Ask: "What is the major difference between a 'small' farm and a modern 'agri-business'?" (consider size, type, and variety of crops raised, use of machinery, etc.)
2. Ask: "What is the major difference between agricultural methods of today and 100 years ago?" (oats and animals to do work instead of gasoline and machinery; monoculture instead of crop variety; synthetic fertilizers instead of manure; irrigation, etc.)
3. Note the similarities between the small family farm and the farms of the past.
4. Investigate the effects of monoculture (one crop) on the use of energy. (need more pesticides, fertilizers)
5. Ask: "How has the need for pesticides increased with the practice of monoculture?" (whole fields of crops of only one kind provide a haven for the insects that live on that particular crop species, so they would multiply tremendously if not controlled with poisons)
6. Farmers say that the cost of wheat is only a small part of the cost of bread. Ask: "What makes the cost so high?" (transportation, packaging, marketing--all high energy users)

Extending the lesson:

1. Draw a mural showing the development of agriculture in the U.S.
2. Discuss the effect on the U.S. economy of exporting farm crops which have been produced at great energy expense.

EIGHTH GRADE, UNIT III

3. Investigate the farming practices of China. (use of human labor, manure, etc.)
4. Investigate the potential for competition between farmers, truckers, auto owners, and boat owners for scarce diesel fuel.
5. Add to the class energy word list.

EIGHTH GRADE, UNIT III

(Science, History, Art,
Social Studies)

UNIT III

2. Title: Lighting

Concept: Energy can be changed from one form to another.

Objective: To discover the relationship between electricity and lighting

Introducing the lesson:

1. List all the ways people have devised to light their dwellings and the places where they work.
2. Put the items on the class list in their correct order in terms of their historical development.
3. Ask: "What is light?"

Developing the lesson:

1. Ask: "What changes in society caused the increased demand for lighting?" (reading; need to light factories)
2. Investigate the research of inventor Thomas Edison in the development of the incandescent light bulb.
3. Discuss the changes in people's lives as a result of Edison's invention of the incandescent light bulb. (work, sports, movies at night, reading, social concentration, etc.)
4. Edison called his development of the first electric generating and distribution plant his greatest achievement. Ask the class if they agree.
5. Discuss its effects on the world and its people.
6. Ask: "Why was lighting essential for the development of the modern skyscraper building?"
7. Lighting takes 2 per cent of the electricity produced in Florida. Ask the students to suggest ways this total might be decreased.
8. Measure the light intensity in your building and compare it with the state standard for lighting schools. (70 foot candles)
9. Locate any over-lit areas.

Extending the lesson:

1. Investigate the use of coal gas and natural gas for street lamps in cities.

2. Plan a lighting conservation plan for your:
 - a. school
 - b. home
 - c. community.
3. Rank the uses of lighting in your school according to their importance. (Is there a difference in values?)
4. Ask: "Would you be willing to give up night athletic events in order to conserve energy?"
5. Discuss the possible effects of such a measure on:
 - a. you
 - b. your school
 - c. your community.
6. Make a poster or collage showing alternative sources of light. (other than electricity - candle, whale oil lamp, etc.)
7. Add to the class energy vocabulary list.

UNIT III

3. Title: Entropy

Concept: When energy is changed from one form to another, some energy is lost.

Objective: To discover the relationship between different forms of energy as they change

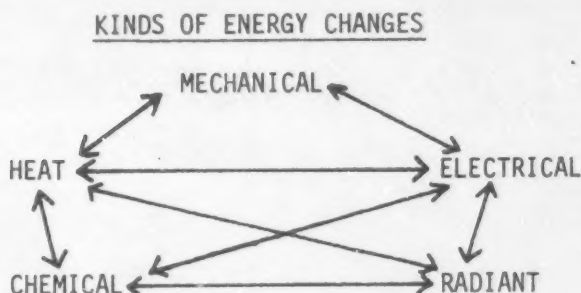
Introducing the lesson:

1. In 1850, the German physicist Rudolf Clausius described the 2nd Law of Thermodynamics as follows:

"It is impossible for a self-acting machine, unaided by any external agency, to convert heat from one body to another at a higher temperature."

Today the 2nd Law is known as the Law of Entropy. In modern terms: "we can't break even," since energy constantly flows from a higher to a lower level; or since energy constantly changes from a higher to a lower form. Ask: "What is lost?" (in any change of energy form, heat is lost)

2. Put the following diagram on the chalkboard:



3. Ask: "What do the arrows represent?" (changes from one form of energy to another)

Developing the lesson:

1. Give examples of each kind of change represented in the diagram. (a chemical reaction such as burning fuel can yield both heat and light; heat, in turn, makes steam; and mechanical energy from a steam engine can be used to generate electricity. In each step, some heat is lost. At the same time, sunlight helps create electrical storms)
2. Investigate Carnot's research with steam engines. Ask: "What did he discover about heat and work?" (heat does

work only when it flows from a warmer to a cooler place; the greater the difference in heat, the more work can be done)

3. Ask: "What happens to heat in automobile engines, tea kettles, smoke, warm air?" (lost to atmosphere)
4. Find examples of people's efforts to get rid of excess heat of entropy. (cooling systems, car radiators, air-cooled engines, cooling towers in power plants)
5. Ask: "How does friction affect movement of air, water, sliding child, tires on a road, etc.?" (all slowed down, and heat produced and lost)
6. Investigate how heat is lost in transmission of electricity. (poor insulators, wires resistance, bad splices, storm damage, transformer heating, generator friction)

Extending the lesson:

1. Investigate efforts to produce a perpetual motion machine which would defy the Law of Entropy.
2. Describe a dream machine of your own design.
3. Describe the world when all the heat has been lost (not possible as long as the sun continues to shine)
4. Describe the effects of entropy in a food chain. (loss of energy at each step in the form of heat)
5. Ask: "Why would it be more efficient for people to eat vegetable matter than meat?" (cow uses up and loses energy in making meat)
6. Add to the class energy word list.

EIGHTH GRADE, UNIT IV

(History, Science, Language
Arts, Music, Art)

UNIT IV

1. Title: Brother Sun

Concept: Life on earth depends on the sun.

Objective: To discover the relationship between people and the sun throughout the ages.

Introducing the lesson:

1. Read to the class the song to the sun written by St. Francis of Assisi in 1224:
Praise to you, my Master, for all your creatures,
Foremost for lordly Brother Sun
Who lights our daytime for us.
He is a beautiful thing who spreads forth a great splendor,
Of You Most High, he is the visible emblem.
2. Ask: "Why have people through the ages felt such strong emotions when they contemplated the wonders of the sun?"

Developing the lesson:

1. Ask the students to comment on Henry Thoreau's comparison of daybreak and the rising of the sun with spiritual awakening.
2. Write a new verse to the John Denver song "Sunshine".
3. Find two or more authors who have written about sun power and compare their descriptions of the sun.
4. Write a poem which expresses your feeling about the sun.
5. Investigate Inca worship of the sun.
6. Find pictures of the Inca temples to the sun "Father".
7. Find "Sun Fathers" in other cultures.
8. Investigate how the culture of the Sioux Indians looked beyond the power of the sun to the responsibility of people to use it wisely.
9. Comment on how well we have heeded the advice of the Sioux.
10. Investigate the device known as the "Camera Obscura", the dark room prototype of the camera.
11. Read the following passage from the Papago Indian ceremony to the sun:
In the east is the house of the sun.
Up over the top of his roof-beam
The sun climbs and journeys
Over the heads of us
Who make our journey below him.
I stretch my right hand sunward,

Then trace upon my body
The ritual sign.
(this ritual, called a "ciwiltkona" is performed by dancers
who believe that they recharge themselves with the sun's energy
as they circle a sand painting of the sun.)

Extending the lesson:

1. Ask the students to describe the warm red pulse of the sun;
its light reaching into them; their feelings as they watch its
wonders of shore and sky.
2. Draw a picture of yourself enjoying the sun.
3. Describe your picture.
4. Set the words of the "sun songs" to music.
5. Add to the class energy vocabulary list.

UNIT IV

2. Title: Heat Pumps

Concept: Heat can be transferred between the natural environment and the man-made environment.

Objective: To discover the relationships involved in heat transfer to and from the natural environment

Introducing the lesson:

1. Say: "At last we have a device which seems to defy the laws of thermodynamics. It produces more energy as heat than is contained in the fuel used to operate it - the heat pump".
2. Ask: "How could heat pumps benefit the energy conservation effort in the State of Florida?"
3. Collect information on heat pumps for heating and air conditioning from local stores.

Developing the lesson:

1. Investigate the operation of a heat pump. (operates on the same principle as a refrigerator - alternate evaporation and condensation of a heat transfer agent, Freon, ammonia, etc., to take heat energy from a colder area (inside refrigerator) and pump it into a hotter area (kitchen), but unlike refrigerators, the heat pump can be reversed to provide heat instead of removing it)
2. Investigate the heat given off by a refrigerator. Feel the coils under or behind the unit.
3. Ask: "Is the heat given off by a refrigerator wasted?" (it is not only wasted, but is released into a kitchen from which it may have to be removed by an air conditioner)
4. Ask: "What is the source of the heat required for the evaporation of the heat transfer agent?" (outside air)
5. Compare the heating and cooling cycles of the heat pump. (in summer, heat needed for evaporation of heat transfer agent is taken from inside the house. This evaporation cools the coils and surrounding air. This cooled air is then blown into the room by a fan = air conditioning. In winter, the cycle is reversed. Heat is drawn from the outside air, further cooling it. When blown into a room during the condensation stage, the heat warms the room, or supplements the regular room heating)

Extending the lesson:

1. Investigate the development of heat pumps by pioneer inventors Sadi Carnot, Rudolf Clausius, and Lord Kelvin.

2. Find out why heat pumps are not more widely used. (no effort by electric utility companies, manufacturers, or retail stores to inform the public of their usefulness and energy conservation value. There were also operational problems with earlier models. Heat pumps are now being promoted as energy conservers)
3. Ask: "Why should utility companies be expected to promote a device that saves electricity?"
4. Investigate why heat pumps work more efficiently in Florida than in the northern U.S. (freezing temperatures form frost on outside coils, reducing pump efficiency)
5. Investigate the differences between water to air heat pumps and air to air heat pumps, and the advantages or disadvantages of each type.
6. Add to the class energy vocabulary list.

EIGHTH GRADE, UNIT IV
(Science, Social Studies,
History)

UNIT IV

3. Title: People Use The Sun

Concept: The sun is the earth's principal source of radiant energy.

Objective: To discover the relationship between the sun's energy and people's use of it

Introducing the lesson:

1. People have used the energy of the sun through all of history.
Ask: "Why do we use so little of the sun's radiant energy now?" (energy comes to earth in very diffuse form and concentrating it for use requires extensive and, so far, very expensive technology)
2. Ask: "Do we use any of the sun's energy directly?" (only for evaporation and passive home heating)
3. Ask: "Why is there renewed interest in solar energy?" (days of cheap fossil fuels are over. Uses of solar energy once considered too expensive are now no more expensive than other kinds of energy)

Developing the lesson:

1. Investigate the use of direct solar energy in making salt by evaporation near San Francisco Bay.
2. Investigate the construction of solar furnaces in the French Pyreness at Mont Louis by Felix Trombe. (3500 mirrors focus on a small area, producing temperatures of over 6000 degrees Fahrenheit)
3. Investigate efforts to produce solar cookers. (research of Mouchot, Dr. Abbott, etc.)
4. Ask: "Why have efforts to provide solar cookers to people in underdeveloped countries been generally unsuccessful?" (high cost; even \$10 is more than people can afford)
5. Investigate the development and use of solar water heaters for pools and home heating in Florida.
6. Ask: "Why have solar furnaces not been used?" (research for their development halted when cheap fossil fuels became available)

Extending the lesson:

1. Read in an encyclopedia about people's search for and use of salt produced by natural evaporation. (include Florida and other southern states during the Civil War)
2. Investigate the formation of the Bonneville Salt Flats in Utah.

EIGHTH GRADE, UNIT IV

3. Ask: "How did the cultural eating habits of people in India and Mexico and other hot countries work against the hopes for use of solar cookers to replace cooking with scarce wood?" (they eat their big meal at night, not during the day when a solar cooker could be used)
4. Build a simple fresh water still with a sheet of plastic and a collecting jar.
5. A farmer in Michigan is operating a solar still to make corn alcohol (moonshine) with which he is operating all of his farm machinery. Ask: "Does this sound feasible?"
6. Investigate the use of alcohol to make "gasohol" for use in automobile engines.
7. Add to the class energy vocabulary list.

EIGHTH GRADE, UNIT V

(Social Studies, Pre-Driver's
Education, Art, Music)

UNIT V

1. Title: Autos, Autos, Autos

Concept: The automobile is the most personal form of mechanized transport.

Objective: To discover the relationship between people and their automobiles

Introducing the lesson:

1. Ask the students to list the things they most look forward to having when they reach their 16th birthday.
2. Make a class list.
3. Rank the items on the list from those mentioned most to those mentioned only once. (certainly at or near the top of the list will be "getting my driver's license")

Developing the lesson:

1. Draw a picture of yourself driving the family automobile on your 16th birthday.
2. Describe how you feel in the picture.
3. Investigate the changes in the life-styles of people following the development of the Model-T Ford by Henry Ford and developments in automobiles since. Discuss automobiles and:
 - a. shopping centers
 - b. leisure activities
 - c. recreation
 - d. pace of life
 - e. eating habits
4. Investigate the development of shopping malls and their effect on the downtown areas of cities.
5. Ask: "How has driver education contributed to the desire to drive in young people?"
6. Ask: "Why do automobile dealers offer free cars to driver education programs?" (belief that people will buy the type of car in which they learned to drive)
7. Discuss the good and bad effects of the automobile on people and their environment. (roads, parking, etc.)

EIGHTH GRADE, UNIT V

8. Ask: "How has the automobile influenced the growth of suburban living?"
9. Discuss the kinds of automobiles which have had the greatest impact on people's lives. (Model-T, vans, station wagons, campers, etc.)
10. How about school busses?

Extending the lesson:

1. Draw a picture of yourself if your parents curtail use of the family car because of the gasoline shortage.
2. Ask: "How has the automobile changed medical care?" (doctors used to travel to their patients, now patients are driven to doctors)
3. Discuss how "fast-food" and "take-out" restaurants would be affected by a ban on pleasure driving.
4. Now, discuss how this would affect your lives.
5. How about motels, drive-in theatres, etc.?
6. Considering our dependence on the automobile as a way of life in the U.S., could we go back to an earlier life-style without automobiles?
7. Investigate the life in Davis, California, a city in which automobiles are not allowed.
8. Draw a picture of your community without automobiles.
9. Write the lyrics to a song entitled, "I Love My Car".
10. Add to the class energy vocabulary list.

EIGHTH GRADE, UNIT V

(History, Social Studies,
Geography)

UNIT V

2. Title: Energy To Get Energy

Concept: It takes energy to produce energy for people's use.

Objective: To discover the relationship between the production of energy sources and the cost of energy

Introducing the lesson:

1. In 1859, the first oil well drilled in the U.S. at Titusville, Pennsylvania was 69 feet deep and produced 500,000 gallons of crude oil during the first year. The crude oil sold for 60 cents a barrel. The deepest wells now go down over 30,000 feet into the earth and their crude oil will cost \$20 or more a barrel. Ask: "Why is the price of oil getting higher all the time?" (there are no more 69 foot wells; equipment for drilling and refining is expensive; much energy and labor needed; new supplies are far away and in harsh environments)
2. Collect pictures of Alaskan pipeline, offshore drilling rigs, supertankers, men working in harsh environments.

Developing the lesson:

1. Make an in-depth study of the Alaskan pipeline: location; distance; weather; terrain; environmental impact; politics; economics; etc. (this is a classic example of just about every problem with which this lesson deals)
2. Investigate the costs in energy (including dollars) of oil exploration, drilling, transportation to refinery, refining, transportation to user, cost to user.
3. Ask: "Why is the price of energy getting higher all the time?" (more energy used to find it, produce it, and deliver it)
4. Investigate process of offshore drilling for oil. (same as on land, only platform is out over deep and rough water)
5. Investigate the increased cost of unleaded gasoline. (requires higher refinery temperatures and pressures; added chemicals to increase octane rating)
6. Investigate efforts to recover additional oil from old wells.
7. Ask: "Why wasn't this oil pumped out before?" (too costly, but it is now economically feasible as the price of oil rises)
8. Investigate the effects of oil spills at the terminal for

North Sea oil in Scotland. (damage to sheep and their famous Shetland wool, which is plucked, not sheared, from the sheep, and damage to seaweed on which sheep feed)

9. Explore the effects of offshore oil rigs on marine life. (generally good, as an artificial reef; spills may destroy whole marine environments)

Extending the lesson:

1. Draw a picture of yourself working on an oil rig.
2. Describe a world in which all energy supplies cost more to produce than the energy they contain.
3. Write a short play dealing with life after oil supplies are gone.
4. Discuss the difficulties in getting politicians to develop an energy policy and an energy conservation program. (issues complex, involving multiple interests)
5. Investigate the results of exploration for oil in the Gulf of Mexico, along Florida's coasts, and in the Big Cypress area of southwest Florida.
6. Ask: "Is this a valid statement?": It takes several years between discovery of new energy sources and their availability on the market.
7. Has this always been true?
8. Add to the class energy vocabulary list.

EIGHTH GRADE, UNIT V
(Science, Social Studies, Art)

UNIT V

3. Title: Energy Use In The U.S.

Concept: People use energy to satisfy their needs.

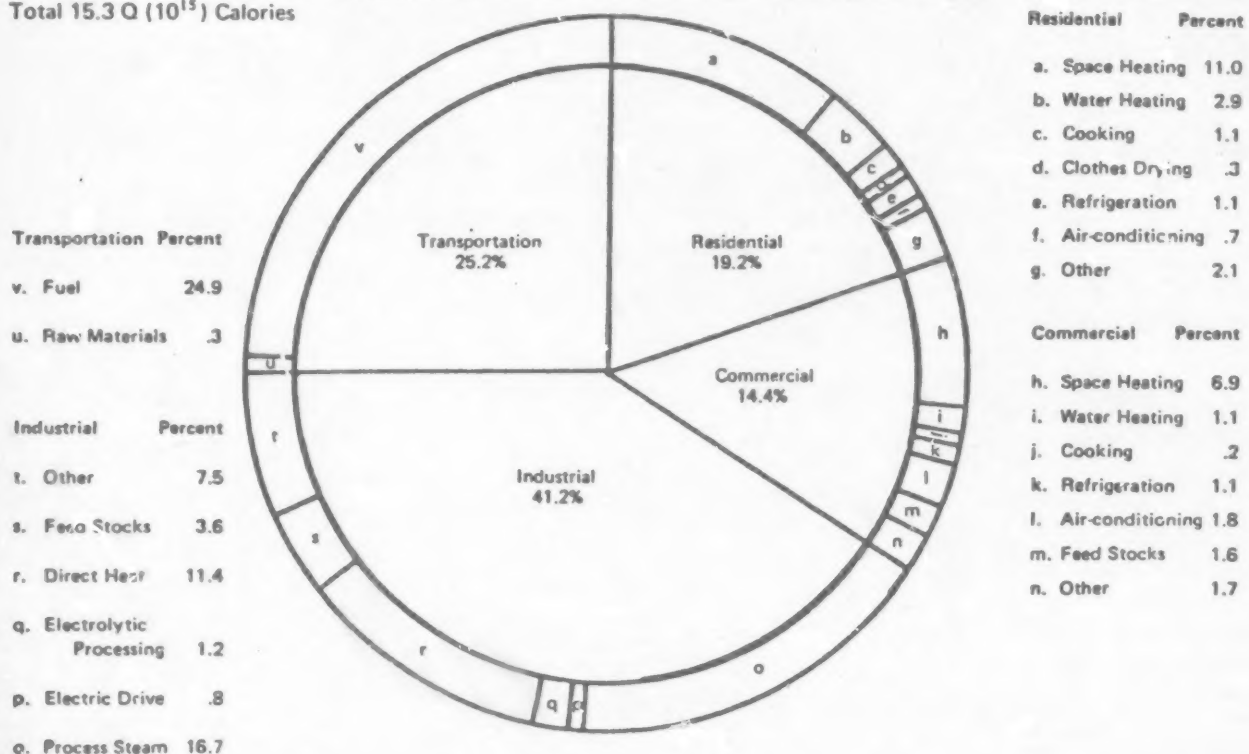
Objective: To discover the relationship between people's needs and their use of energy

Introducing the lesson:

1. Copy the chart below on the blackboard. The chart shows U.S. energy use in 1968 as compiled by the U.S. Office of Science and Technology. (although the amounts of energy used have increased tremendously since 1968, there has been little change in the percentages used by the various sectors of the economy)
2. Note the four major-use sectors: Industrial; Commercial; Residential; and Transportation; and the percentages of energy used by each sector.

Breakdown of U.S. Energy Consumption, 1968

Total 15.3 Q (10^{15}) Calories



Source: Patterns of Energy Consumption in the United States, Office of Science and Technology, Executive Office of the President, Washington, D.C., 1972.

Developing the lesson:

1. Discuss the use items within each sector.
2. Discuss the item "feed stocks" and their importance. (raw materials used to make synthetic products)
3. Discuss the relative effect of doing without fuel or feed stocks because of fossil fuel shortages. Which would we miss most?
4. On the basis of a survey of stores in a shopping center, predict whether the amount of oil used for synthetic materials and fibers will increase or decrease. (use is increasing rapidly - check shoes, clothes, etc. from China, Taiwan, Korea, Italy)
5. Study the chart again. Place an asterisk * beside every item that could be accomplished with electricity. (use of electricity is growing fastest of all energy forms)
6. Discuss problems of increasing use of electricity. (black-outs threaten almost every item on the chart)

Extending the lesson:

1. Discuss whether uses listed in the chart are really uses or conversions of energy to another form.
2. Ask: "Why is there so little direct use of energy without conversion; for example, direct use of wind in sailing?"
3. Draw a picture of a family in an all-electric home without electricity. (this often happens after northern ice storms)
4. Discuss a program to save electricity for each of the asterisk items on the chart.
5. Add to the class energy vocabulary list.

UNIT VI

1. Title: Limits To Electric Power

Concept: Energy supplies are limited.

Objective: To discover the relationship between supply and demand for electric power

Introducing the lesson:

1. Show a power company advertisement which stresses energy savings. Ask: "Why would an electric power company be asking people to conserve electricity when they formerly encouraged people to use more and more electricity?" (concern about their ability to supply all the electric power the public demands)

Developing the lesson:

1. Investigate the reasons for the concern about future supplies of electricity:
 - a. Growth in consumption
 - 1.) commercial (greatest - space heating, cooling, lighting)
 - 2.) residential - (increasing population, more appliances, more inefficient appliances - "frost free")
 - 3.) industrial - more waste in use of electricity instead of oil, electric furnaces, synthetics)
 - 4.) transportation - more electric trains
 - b. Increase in waste - electricity wastes 50-60% of fuel used to produce it (heat)
 - c. Substitution of electric power for manpower
2. Discuss effects of substitution of electric power for manpower in industry. (a few people can now operate a factory that formerly employed hundreds -- unemployment, increased demand for electricity)
3. Experts predict a doubled demand for electricity by the year 2000. Discuss the effects on:
 - a. number of power plants
 - b. the environment
 - c. costs of construction
 - d. building supplies

4. Investigate the effects on increased demand for electricity of:
 - a. price of electricity (usually cuts demand)
 - b. population growth (increase)
 - c. economic state (depression decreases demand)
 - d. cost of fuels (will determine cost of electricity)
5. Investigate the growth of demand for electricity worldwide.

Extending the lesson:

1. Discuss the pros and cons of siting a new electric power plant in your community or along your favorite stream.
2. Discuss the future of nuclear power plants. (even without the public concern for the safety and the problems of waste disposal, excessive construction and environmental constraints are making nuclear plants too costly to be economically competitive with coal)
3. Investigate the future of coal as a fuel to produce electricity. (plentiful, but lack of transportation into Florida, and environmental constraints will limit its use, at least until railroads are updated)
4. Ask: "Can we satisfy the predicted doubling in demand for electricity?" (only if we are willing to compromise the environmental effects of using coal as a fuel in electric power plants)
5. Add to the class energy vocabulary list.

EIGHTH GRADE, UNIT VI

(Science, Social Studies,
Geography, Art)

UNIT VI

2. Title: Life With Limited Energy

Concept: Some people use more energy than others.

Objective: To discover the relationship between people's life-styles and their use of energy

Introducing the lesson:

1. Ask the class to collect pictures and news stories of energy supply and use in the nations of the world. (be sure not to overlook human power)
2. Assign each student one nation to study and report on.
3. Make a bulletin board display of the pictures and news stories collected.

Developing the lesson:

1. Ask each student to give a short report on energy supply and use in the assigned nation.
2. Investigate patterns of energy supply and use in rural, suburban, urban, and inner city areas.
3. Compare these areas in terms of energy use; energy waste.
4. Compare them in terms of energy conservation.
5. Have the class pick out the five nations that seem most unusual or different from the average in terms of energy use and compare them in terms of:
 - a. food
 - b. industry
 - c. agriculture
 - d. transportation
 - e. use of electricity
 - f. most common fuel

Extending the lesson:

1. Do a similar comparison for states in each section of the U.S.
2. Discuss the relationships of energy use and environmental problems; for example:

- a. firewood for cooking is scarce, so people use dried cow manure for fuel. This causes shortage of fertilizer, which results in a smaller crop; less food to cook)
3. Investigate the Kaplan project in Bartow, Florida which uses wastes from cattle feed lots to produce methane gas.
4. The U.S. has 7% of the world's population, but uses 35 to 40% of the world's energy. Discuss how the U.S. must depend on other nations for some of its energy supplies.
5. Discuss the relationship between energy use and life-styles.
6. Draw a picture of yourself living in an energy-poor country.
7. Now draw a picture of yourself in the U.S. if energy supplies are limited.
8. Discuss the differences between your pictures.
9. Add to the class energy vocabulary list.

UNIT VI

3. Title: Energy Conflict

Concept: Energy shortages lead to conflict.

Objective: To discover the relationship between supply and demands for energy

Introducing the lesson:

1. Divide the class into 6 groups; each group controls all of one of the following resources in the world: wood; oil; coal; uranium ore; hydro-electric power; irrigation rights. (you may want to have a group for raw materials)
2. Ask each group to meet to consider how it would use its monopoly of one resource to exert influence or power on the rest of the world.

Developing the lesson:

1. Ask each group to design a butcher paper display to show their plan for exerting their power in world politics. (they may use charts, graphs, drawings, whatever)
2. Have each group present their plan to the class. (You will be able to judge the time allotted by the interest shown in the preparation of the group presentation)
3. Discuss any apparent conflicts which may have to be resolved.
4. Form a committee of one member from each group to meet to discuss any possible compromises that might be worked out to resolve conflicting positions.
5. Have the committee report to the class, and discuss the committee proposal.
6. Ask: "What happens if the conflicting plans cannot be resolved in committee?" (conflict, war)
7. Investigate the history of energy conflict.

Extending the lesson:

1. Find out what resources people fought for in wars in which the U.S. was involved:
 - a. Revolutionary
 - b. Spanish-American
 - c. Civil
 - d. World War I

- e. World War II
 - f. Korean
 - g. Vietnam
 - h. Middle-East
2. Do the same for ancient wars: Persian; Greek; Roman; French-Russian.
 3. Investigate the influence of Nigeria's oil supplies to the U.S. on American policy toward Rhodesia. (Recognition of new government might offend Nigeria)
 4. Ask: "Why did some U.S. officials recommend military action to guarantee Mid-East oil supplies to the U.S.?" (oil supplies so vital to national interest that cut-off of oil supplies is considered an attack on the U.S.)
 5. Find people who wage quiet wars with human energy.
 6. Find others who use their energy to make peace.
 7. Add to the class energy vocabulary list.

UNIT VII

1. Title: A Second Coal Age?

Concept: People depend on their environment for their energy.

Objective: To discover the relationship between energy supplies and the lives of people

Introducing the lesson:

1. Say: "One hundred years ago, the nation ran on coal. Then coal was replaced by the cleaner burning and much cheaper oil as the principal source of energy. Now, it appears that, as oil becomes scarce, we may once again become a nation driven by coal".
2. Ask: "Do you think this is true?"

Developing the lesson:

1. Investigate the advantages of coal in terms of:
 - a. abundance (we have enough for centuries)
 - b. accessibility (we know where it is and how to get it; no costly exploration is needed)
 - c. cost (half the price of oil per unit of energy)
 - d. uses (a very versatile fuel and can be converted to oil or gas)
2. Investigate the disadvantages of use of coal as a fuel. (high sulphur content = air pollution, acid rain; mining hazards; environmental hazards - acid wastes; difficulty of reclamation of strip-mined lands)
3. Discuss industry and governmental recommendations that environmental restrictions on mining and burning coal be removed to increase production, at least until technology can be developed to remove sulphur and eliminate acid wastes.
4. Ask: "What is coal?" (request samples from local utility)
5. Investigate stages in the formation of coal. (peat, lignite, bituminous, anthracite)
6. Investigate the location of the world's coal reserves.

Extending the lesson:

1. Investigate the productivity of a coal miner. (10-15 tons per day but dropping rapidly during recent years)
2. Find out how coal is used in your area and how it is transported.

EIGHTH GRADE, UNIT VII

3. Ask: "What is a 'captive mine'?" (a mine owned by a utility company to guarantee future supplies of coal)
4. Calculate the amount of coal it would take to supply your energy needs and the energy needs of your school. (one lb. of coal = one kilowatt hour of electric power)
5. Draw a picture of your home and school in the "Second Coal Age".
6. Describe your life if all the environmental effects of using coal are eliminated. (plenty of energy but very expensive)
7. Investigate regulations to increase mine safety.
8. Add to the class energy vocabulary list.

EIGHTH GRADE, UNIT VII

(Social Studies, Geography,
Mathematics, Art)

UNIT VII

2. Title: Societies Change

Concept: The life-styles of people reflect the availability of energy.

Objective: To discover the relationship between energy supplies and the lives of people

Introducing the lesson:

1. Ask the students to compare their energy use with that of an Eskimo.
2. Ask: "How is the comparison changing?" (Eskimos now have electricity, snowmobiles; rarely use dog sleds and whale oil lamps)

Developing the lesson:

1. Compare people's needs for energy in an industrial nation with that of a developing nation.
2. Investigate the development of the "Green Revolution". (name for intensive program to increase food production in Asia and South America by American scientists)
3. Ask: "What were the major ingredients of the program?" (hybrid seeds, fertilizers, irrigation, pesticides, and farm machinery, all high energy users)
4. Investigate problems which resulted when high energy farm methods were introduced into nations with limited energy and money. (loss of disease-resistant native varieties of rice and wheat, lack of water for irrigation, costs)
5. Ask: "What kind of energy are the poor people of the world interested in?" (food for human energy or fuel for cooking)
6. Check the validity of the statement: "If the poor people of the world had all the food they needed, they would not have enough fuel to cook it". (true)
7. If this statement is true, discuss its implications for the future. (overpopulation can only increase shortages)
8. How has the increase in the world's population affected various societies and nations?

Extending the lesson:

1. Calculate how many people the earth could support at the U.S. standard of living. (our 200 million people use nearly one-third of the world's energy, so the earth could support three times as many people as the U.S. standard of

living or 600 million)

2. How many could the earth support at the standard of living of the people of China? (1 billion people use less than 10% of the world's energy ; over 10 billion)
3. Draw a picture showing Americans visiting a poor nation.
4. Draw a mural showing poor people visiting the U.S.
5. Draw a picture of yourself in a new society that has been forced to live on a limited energy budget.
6. Describe your new society and life in it.
7. List the items you own but would have to give up in the new society.
8. Ask: "Is it fair for our society to use up the fuels on which future societies must depend?"
9. Add to the class energy vocabulary list.

UNIT VII

3. Title: Clean Air?

Concept: People and environments are dependent on one another.

Objective: To discover the environmental costs of our high energy technological society

Introducing the lesson:

1. Ask the students to list the measures that state and Federal governments have taken to control pollution of air and water.
2. Investigate the role of the U.S. Environmental Protection Agency and the Florida Department of Environmental Regulation in setting up and enforcing air and water pollution control regulations.

Developing the lesson:

1. Ask: "What is the role of legislative bodies (Congress and state legislature) in providing clean air?" (they set policy, allowable pollution levels, set up and fund regulatory agencies)
2. List the major polluters of the atmosphere and the pollutants they produce. (automobile - smog, nitrogen oxides, carbon monoxide, lead; electric power plants - sulphur dioxide, soot, ashes, excess heat)
3. Investigate the operation of emission control devices on automobiles and the loss of gasoline mileage. (7%)
4. Discuss whether clean air standards should be eased to increase gasoline mileage.
5. Investigate costs of air pollution. (approximately \$20 billion per year: health effects; effects on materials--rust and corrosion; effects on homes - paint; crop damage; aesthetic effects)
6. Investigate the formation of acid rain. (sulphur dioxide from burning fossil fuels combines with water vapor to form sulphuric acid which falls to earth in rain. It is causing erosion of marble buildings and statues worldwide)
7. Investigate air quality standards for your local power plant and the supply problems they cause. What is being done to reduce air pollution?

Extending the lesson:

1. Ask: "Do you favor relaxing clean air standards in order to provide cheaper electricity?"

2. Discuss this or have a debate if opinions differ widely.
3. Write a trial on clean air violations.
4. Draw a picture of your community if there were no clean air standards.
5. Draw another picture showing your community with a solar electric power plant.
6. Ask: "Do the values of people vary according to the effects of the pollution or regulations on them?"
7. Discuss the values expressed.
8. How can the problems of both power production and air pollution be solved?
9. Add to the class energy vocabulary list.

NINTH GRADE, UNIT I

(Science, Mathematics, Art,
Social Studies, Language Arts)

UNIT I

1. Title: A Solar Farm

Concept: People use energy to do their work.

Objective: To discover the relationship between direct solar energy and people's use of it

Introducing the lesson:

1. Ask the students to suggest words that describe a farm. Write them in columns on the chalkboard as fast as you hear them. Make it a game to go faster than they do.
2. Read in the Meinel Book, "Power For The People", or in the NSTA Source Book about the Meinel proposal to build a huge solar "farm" in the southwestern U.S.

Developing the lesson:

1. Investigate the cycle for capturing the sun's energy and using it. (trap solar radiation in collectors; pump heat to a central power plant; generate steam; and produce electricity with steam turbines)
2. Describe the "rows" on the farm. (rows of solar collectors with mirrors to focus sunlight on black pipes filled with liquid sodium to carry the heat. The whole collector is enclosed in a transparent vacuum half cylinder)
3. Ask: "What is the crop?" (heat - temperatures as high as 1000 degrees Fahrenheit)
4. Ask: "What happens on cloudy days?" (heated sodium flows to a storage tank which could hold heat for a few days and continue to generate electricity)
5. Investigate how much electricity could be produced on a solar farm. (a farm of 10,000 square miles, 100 miles on a side, could produce half of the nation's need for electricity in the year 2000 according to Meinel)
6. Ask: "Isn't that a lot of land to use?" (yes, but in the southwestern U.S., 10,000 square miles is only a tiny fraction of the area of relatively unused desert)
7. How does the efficiency of a solar farm compare with the efficiency of a standard electric generating plant? (both operate about 30% efficiency, but after the initial installation of the solar collecting equipment, fuel is free)

Extending the lesson:

1. Draw a picture or diagram of a solar farm.

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2. Discuss this use of direct solar energy by people.
3. Ask: "What could a development like the solar farm proposed by the Meinels mean for the future?" (cheap, plentiful electricity, although there would still be a great loss in transmission of electricity if all the solar farms for the U.S. were located in the southwestern U.S.)
4. Debate whether or not it would be feasible to set aside 10,000 square miles of Florida land to build a solar farm. (Would it be as good to use land for citrus farming?)
5. Start a class energy vocabulary list.

NINTH GRADE, UNIT I

(Science, Vo Tech, Mathematics,
Language Arts, Art, Social Studies)

UNIT I

2. Title: Efficiency

Concept: People's machines waste energy in doing work.

Objective: To discover the relationship between the efficiency
of people and machines

Introducing the lesson:

1. Ask the class to describe an efficient person. (One who gets work done with an apparent minimum of effort or wasted energy)
2. Discuss whether the same definition of efficiency would apply to a machine. (Yes, the efficiency of a machine is the ratio of the work done to the energy used to do the work)

Developing the lesson:

1. Find out how efficiency is determined. (divide work done by energy used and multiply by 100 = % efficiency)
2. What is lost that determines efficiency? (heat)
3. Ask the students to rate the following energy conversion processes in terms of their efficiency from highest to lowest. (these are in the correct order; be sure to give them to the students in a different order):

electric generator - 95%	steam power plant - 40%
dry cell battery - 90%	diesel engine - 35%
large electric motor - 90%	automobile engine - 25%
storage battery - 75%	flourescent lamp - 20%
small electric motor - 65%	steam locomotive - 10%
steam turbine - 50%	incandescent light bulb - 2%

4. Compare our major uses of energy with the efficiency ratings; for example, $\frac{1}{4}$ of our energy is used in producing electricity in plants with an efficiency of 30% or less.
5. Compare use and efficiency for transportation.
6. Ask: "Why are engines so inefficient?" (many moving parts, plus burning fuel = a lot of heat loss)
7. Investigate how the efficiency of automobiles expressed in miles per gallon has been increased in recent years. (lighter cars, high compression; could be increased more

NINTH GRADE, UNIT I

except for use of air-conditioning)

8. Ask: "What helps to keep automobile efficiency low?" (automatic transmissions, power brakes, air-conditioning)

Extending the lesson:

1. Deliver a two-minute sermon on the evils of inefficiency.
2. Draw a picture of an inefficient, low-energy transportation system. (hiker, Himalayan porters, bicyclist, etc.)
3. Describe your efficient transportation.
4. Compare the efficiency of automobiles and airplanes in moving 100 people from Atlanta to Tampa. (According to one of the major airlines, a Boeing 727 uses approximately 1860 gallons of fuel per hour. It is approximately 1½ hours flying time from Tampa to Atlanta. The 727 would use approximately _____ (2800) gallons of fuel from Tampa to Atlanta. If automobiles average 16 miles per gallon and the distance from Tampa to Atlanta is 960 miles, it would take ____ (60) gallons of fuel for an automobile to go from Tampa to Atlanta. At the average of 2 persons per automobile, at the above rate, how many gallons would it take for 100 persons in 50 cars? _____ (3000) Calculate the amount of gallons required to take 100 persons in a 727 and by automobile (varying numbers of passengers per automobile). Make up your own problems and do calculations using the following data:

Type of Plane	Number of Gallons	Passenger Limits
Boeing 727	1860 per hour 31 per min.	137
DC-10	2730 per hour 45 per min.	327

Even without the above data, it is more energy efficient to fly on a regularly scheduled airliner. Why? (planes will be flying anyway)

5. Make the same comparisons for trains and trucks used to move freight. (trains use ¼ of the amount of energy to move the same amount of freight)
6. What other factors might be considered in deciding how to move freight. (perishable cargo, etc.)
7. What other factors increase overall efficiency of trains as compared to automobiles? (trains use energy to move their cargo; most energy used in cars is used to move the vehicle, not the cargo)
8. Add new energy words to the class energy vocabulary list.

NINTH GRADE, UNIT I

(Science, Social Studies,
History, Geography)

UNIT I

3. Title: Sea Thermal Power

Concept: The ocean is a huge solar collector and heat engine.

Objective: To discover the relationship between ocean temperature gradients and heat engines

Introducing the lesson:

1. Every person in Florida knows about the warm Gulf Stream which flows north along the east coast of Florida. Ask the students if there is any way that the heat energy of the Gulf Stream could be used. (yes, the ocean is a natural heat engine which could produce electricity if its energy could be captured)
2. In solar power proposals like the solar farm in lesson 1, collectors of solar heat are often too expensive to make the project economically feasible. Ask: "What is the solar heat collector in the Gulf of Mexico?" (the sea itself collects the heat--free)

Developing the lesson:

1. Find out how a heat engine works. (heat engine placed between a high temperature source (the ocean surface) and a low temperature source (deep water in ocean). Heat flows from hot to cold through the heat engine, which converts it to work for electric power production)
2. Ask: "Why is the Gulf Stream a good location for use of a heat engine to produce electric power?" (there is a year-round difference of about 40 degrees between the surface and water 1000 feet below the surface. No seasonal or daily variations)
3. Investigate the research of the French scientist Georges Claude and his development of a sea thermal steam turbine in Cuba in the 1920's.
4. Describe the operation of the Claude power plant in Cuba. (a vacuum pump brought warm surface water to a boil by reducing pressure. Steam was used in a turbine to produce electric power)
5. Why were larger plants not built when they were so successful? (they could not compete economically with plants using newly-developed oil resources)
6. Investigate efforts by the French government to build a sea thermal power plant.
7. Read in Clark's "Energy for Survival" about the proposals of the Andersons of York, Pennsylvania and Dr. William Heronemus of the University of Massachusetts to use sea

NINTH GRADE, UNIT I

thermal power plants to produce electricity or hydrogen for fuel.

Extending the lesson:

1. Some areas of Florida are short of fresh water. Investigate the dual use of a sea thermal power plant to desalinate sea water.
2. Describe the advantages of an underwater ocean power plant. (no storm problems)
3. How would such a system work in polar regions? (even the cold ocean can be a heat source, like the inside of the a refrigerator can give off heat, as long as there is colder air around to act as a heat sink for the plant's condensers)
4. Investigate the possible effects on marine life of a sea thermal power plant in the Gulf Stream. (cold water brought up from bottom would be beneficial to marine life. The greatest concentrations of marine life in the world are in areas where currents bring nutrient-rich cold water to the surface)
5. Investigate how electricity produced could be used to produce hydrogen for a hydrogen-based energy economy. (instead of sending electricity ashore, it would be used to make hydrogen by electrolysis of water. This hydrogen could be transported in existing gas pipelines to local fuel cell plants to make electricity)
6. Ask: "Why don't we build it?"
7. Add to the class energy word list.

NINTH GRADE, UNIT II

(Science, Social Studies,
History, Geography)

UNIT II

1. Title: Animal Power

Concept: Energy comes in many forms.

Objective: To discover the relationship between energy sources and power

Introducing the lesson:

1. Find pictures of various animals being used to do work for people.
2. Make a list of the different animals that have been used by people.

Developing the lesson:

1. Ask: "What animals were first used by people?" (slaves captured in battle - human power)
2. Investigate the use of slave labor in building pyramids, Roman cities, etc.
3. Investigate slavery among Indian tribes.
4. How were other animals first used? (to carry loads and pull loads)
5. How did the invention of the wheel increase the efficiency of animal labor? (reduced energy lost to friction in dragging loads)
6. Rate animals used by man in terms of their strength. (elephant, horse, ox, mule, camel, reindeer, llama, man, dog)
7. Discuss the most unusual animal used by people. (probably reindeer by Laplanders)
8. Investigate the use of dogs in polar exploration.
9. Which animal is most versatile? (horse)
10. Which animal is most widely used? (horse)
11. What is horsepower and why is it used as a measure of power? (first engines were compared to horses in terms of amount of work they could do)

Extending the lesson:

1. Investigate the use of elephants by the Carthaginian general Hannibal in crossing the Alps to invade Rome.

NINTH GRADE, UNIT II

2. Investigate the use of dolphins in underwater research and spy activities.
3. Can you think of an animal which is not a mammal that is used by people to do work?
(cormorant used by Japanese fishermen)
4. Draw a picture of yourself with a favorite animal being used as a beast of burden after fuel supplies are all used up.
5. Describe life on a farm in America before invention of the tractor.
6. Add to the class energy word vocabulary list.

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NINTH GRADE, UNIT II

(Science, Geography, Social
Studies, History, Art)

UNIT II

2. Title: Offshore Oil

Concept: Energy comes in many forms.

Objective: To discover the relationship between crude oil supplies and the search for oil "offshore"

Introducing the lesson:

1. Man has drilled deep into the earth of the continental U.S. Now there is increasing discussion and controversy about offshore oil. Ask: "What is offshore oil?" (oil in the continental shelf in relatively shallow water)
2. Examine a map which shows the location of the continental shelf along the coasts of the U.S.
3. Find pictures of offshore drilling platforms during construction and in operation.

Developing the lesson:

1. Ask: "If there is plenty of oil left as the oil companies say, why are they drilling in the hostile environments of the offshore wells?" (North Sea, Arctic, etc.)
2. Look on a map for the Channel Islands off the California coast, scene of recent offshore exploration and drilling.
3. Investigate the dangers of drilling in this area? (wells are located in a major earthquake zone - the San Andreas fault)
4. Investigate the oil well "blowout" which polluted the beaches of Santa Barbara, California in 1969.
5. Locate the Baltimore Canyon area off the Atlantic coast. Then read about recent attempts to find oil and gas there.
6. Investigate the procedures for obtaining a lease from the U.S. Department of the Interior for drilling rights in areas of the continental shelf.
7. Investigate the problems of constructing drilling platforms in deep and stormy offshore areas.

Extending the lesson:

1. Describe the world when there is no more oil to be found.
2. Read oil company reports and advertisements to find evidence of aesthetic or environmental concern (or lack of it).

NINTH GRADE, UNIT II

3. Read about the great oil spill at a Chevron platform in the Gulf of Mexico in 1970 and the Mexican well in 1979.
4. In an oil company advertisement, comedian Bob Hope drives a golf ball off an offshore platform. Draw a picture of yourself using a platform to do your favorite thing.
5. Draw a mural to show the process of offshore drilling.
6. Investigate the effects of drilling platforms on marine life. (act as artificial reefs; generally thought to be favorable to marine life, although there is some concern about possible long-term effects of spilled oil and other chemicals)
7. Discuss whether oil companies would be drilling offshore and in the Arctic if there were plenty of domestic supplies which needed only financial incentive (Profit) for development.
8. Add to the class energy word list.

NINTH GRADE, UNIT II

(Science, Geography,
Social Studies, Art)

UNIT II

3. Title: Oil From Rocks

Concept: Energy comes in many forms.

Objective: To discover the relationship between energy forms and the natural forces which caused their formation

Introducing the lesson:

1. Ask: "Did you ever hear of oil that is not a liquid?"
(there are two solid forms - oil shale and tar sands)
2. Collect pictures showing the process of recovery of oil from oil shale rocks.

Developing the lesson:

1. Locate on a map of the U.S. the Green River Formation where Utah, Wyoming, and Colorado meet along the Green River, a tributary of the Colorado River.
2. Find out how oil was bound into the rocks. (caught in clay sediments which were turned into shale by heat and pressure)
3. Describe the oil in shale. (called kerogen, a tar-like material which melts at 450-600 degrees Centigrade, releasing vapors that can be converted to shale oil)
4. Ask: "How much oil is there in the Green River Formation?"
(2 trillion barrels, many times the amount of all the easily available oil in the U.S.)
5. Investigate the processes and the energy required for recovery of oil:
 - a. above ground (energy for mining, crushing, heating, waste disposal)
 - b. in situ (in place in the rocks; heating rock, oil recovery, waste).
6. Investigate the recovery problems with each method. (above ground - rock has to be mined, crushed, heated, then waste removed. Rocks expand when heated, so amount of waste material is greater than original rock; in situ - rock has to be broken up by pressure, chemical explosives, or a nuclear explosion, then heated to release oil)
7. Investigate the environmental problems. (vast quantities of water required - could seriously affect already over-committed flow of the Colorado River; waste rock areas impossible to revegetate without water, if at all; area will become a barren wasteland, devoid of wildlife)

Extending the lesson:

1. Investigate the sale and leasing of oil shale lands by the U.S. Department of the Interior.
2. Ask: "Why should the government sell lands containing trillions of barrels of oil to oil companies for a few dollars an acre?" (that's what the laws for mining require)
3. Discuss the pros and cons of encouraging the development of our oil shale reserves. (need versus problems)
4. Ask: "Should we destroy a beautiful section of our western mountains so we can continue our oil-spending and energy-wasting spree?"
5. What are the alternatives?
6. Investigate plans to recover a similar type oil from the Athabasca Tar Sands in Canada.
7. Draw a picture of yourself around a campfire lined with oil shale rocks.
8. Add to the class energy vocabulary list.

NINTH GRADE, UNIT III

(Science, Art, Geography,
Social Studies)

UNIT III

1. Title: Refining Oil

Concept: Energy can be changed from one form to another.

Objective: To discover the relationship between the various kinds of fuels and their production

Introducing the lesson:

1. In oil company reports or publications, find a picture or chart showing the process of refining oil.
2. Have the students make a large mural on the chalkboard or on butcher paper which shows how a refinery operates.

Developing the lesson:

1. Ask: "What does refining mean?" (to make better by removing impurities)
2. Investigate the differences in crude oils. (more or less light or heavy; high or low sulphur content; for example, in Florida, Jay oil is a much better grade than Big Cypress oil; other minerals and impurities)
3. Identify the major components of an oil refinery and give the function of each.
 - a. still or distillation tower - breaks up crude oil into its many chemical components; separates heavy oils from light oils - light oil goes to the top;
 - b. catalytic reformer - rearranges molecules of naptha into high octane gasoline;
 - c. Polymerization plant - converts light oils from top of still to gas and high octane gasoline;
 - d. catalytic (cat) cracker - breaks down heavy oil fractions to lighter fractions;
 - e. gasoline blending tanks - mix "cracked" gasolines into motor fuel; with these, they increase the amount of gasoline per barrel of crude oil.
4. Ask: "What happens to the heavy oils left over after gasoline has been made?" (makes kerosene, jet fuel, diesel fuel, heating oil, lubricants, and residuals; what's left over then becomes power plant fuels, asphalt, waxes)
5. What is the major use of energy in refining oil? (fuels to heat the still; refineries use about 10% of their fuel in the refining process)

NINTH GRADE, UNIT III

6. Discuss how the conflict between use of crude oils for running our society and use for synthetics and chemicals can be resolved. (both uses are growing rapidly)

Extending the lesson:

1. Locate the oil refineries in the U.S.A.
2. Investigate the environmental objections to siting of oil refineries along coasts. (spills; need coasts for recreation)
3. Why not locate refineries inland? (nearly all oil imported, brought in ships)
4. Discuss demands on various products from the oil refineries. (all increasing and conflicting - gasoline or diesel - or heating oil - or synthetics)
5. Where will it all end? (did the strike of truckers in 1979 give us a clue? There will have to be realization that unrestricted growth cannot continue, even if we can harness the free energy of the sun, and that will be expensive)
6. Draw a picture of your community after an oil refinery is built there.
7. Discuss whether you would object to the siting of an oil refinery in your community.
8. Where would you locate it? (it has to be in somebody's community)
9. How would you decide?
10. Add to the class energy vocabulary list.

NINTH GRADE, UNIT III

(Science, Social Studies,
Art)

UNIT III

2. Title: Appropriate Technology

Concept: Energy can be changed from one form to another.

Objective: To discover the relationships between energy in its various forms

Introducing the lesson:

1. Ask: "What does the term 'appropriate technology' mean?" (term used by the U.S. Department of Energy to describe small scale energy-related technologies which are "appropriate" or adapted to local needs skills and available energy resources)
2. Discuss what appropriate technology might mean in Florida. (solar, wind, uses which enhance energy conservation, uses of existing technology)

Developing the lesson:

1. Congress has authorized a small grants program to encourage development of appropriate technology. Ask: "What would be the goals of such a program?"
2. Write to the Department of Energy, Southeast Region, 1655 Peachtree Street, N.E., Atlanta, Georgia, 30309, for information on this small grants program.
3. Investigate the concept of "Total Energy" installation of power systems for schools and small communities (see Clark, page 234)
4. Investigate problems with such installations. (custom design and construction make them expensive; not as convenient as just turning on the power from utility)
5. Review the use of heat pumps. (Lesson 2, Unit IV, grade 8)
6. Investigate the number of solar-heated swimming pools in your community.
7. Is solar heating of water or space being used in your school? If not, why not?

Extending the lesson:

1. Design a class mural showing your community with a total energy power installation and solar collectors on every building.
2. Discuss the value of use of renewable resources such as solar energy and wind. (no supply problem - fuel is free after installation costs are paid)

NINTH GRADE, UNIT III

3. Describe the effects on a community of a "total energy" program. (encourage cooperation and self reliance)
4. Design a plan which would make appropriate technology easier to adapt to local needs, skills, and energy availability.
5. Find out the number of days your community had winds strong enough to operate windmills.
6. Add to the class energy vocabulary list.
7. Go on to the next lesson to learn about another appropriate and energy saving technology.

NINTH GRADE, UNIT III

(Science, Social Studies,
Vocational-Technical)

UNIT III

3. Title: Garbage Power

Concept: Energy can be changed from one form to another.

Objective: To discover the relationship between energy and matter
in organic materials

Introducing the lesson:

1. How to get rid of our mountains of garbage has become an increasingly difficult problem for every community.
Ask: "How does our community dispose of its wastes?"
2. Why don't we burn our organic wastes to produce power?

Developing the lesson:

1. Investigate the formation of methane. Why is it called natural gas? (organic wastes--dead materials--are fermented by anaerobic bacteria--grow in the absence of oxygen--to form methane and carbon dioxide)
2. Ask: "Why cannot people use this age-old natural method to dispose of their organic wastes?" (too many people and mountains of waste)
3. Find out how much waste is generated in your community.
4. Read about the work of Dr. Ram Bux Singh in designing and construction of "Biogas" plants in India.
5. Investigate problems of using sewage effluent from a community in a biogas plant. (too much water, which reduces efficiency of the digester)
6. Discuss how use of cow manure from cattle feed lots in biogas plants could reduce water pollution and waste of a valuable resource. (Kaplan project in Bartow, Florida)
7. Read about the research of Dr. Martin Wolf of the University of Pennsylvania in converting urban wastes to methane. (Clark, page 457)

Extending the lesson:

1. Investigate whether or not your community sewage disposal system uses an anaerobic bacteria process. If so, is the methane produced used to power the plant?
2. Investigate the supply problems of a biogas plant. (major problem is transportation of wastes to the biogas plant)
3. Consider the environmental costs of using animal manure for biogas production. (loss of valuable soil conditioner and fertilizer)

NINTH GRADE, UNIT III

4. Compare energy production of leaves or grass with manure. (leaves generate 7 times as much methane. Remember entropy - the cow used most of the energy in the grass to make meat, so not much left in the manure)
5. Design a methane generator for your home.
6. Investigate the waste problems with a biogas plant. (waste is sludge, undigested material, which may make up 40% of the total fuel. Disposal is a problem unless it is used as a fertilizer or soil conditioner)
7. Add to the class energy word list.

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NINTH GRADE, UNIT IV

(Science, Art)

UNIT IV

1. Title: Light

Concept: The earth receives radiant energy from the sun.

Objective: To discover the relationship between the light of the sun and how people see it

Introducing the lesson:

1. Ask: "What is light?" (a form of the radiant energy of the sun, measured in wave lengths)
2. Have the students describe the light of the sun.
3. Ask: "What does it mean to you?" (write their answers on the chalkboard - brightness, shade, blending of colors, etc.)

Developing the lesson:

1. Investigate the use of lenses and other optical glassware to study light through the ages.
2. Focus lights covered with red, blue, and green lenses or cellophane on the top of a white cue ball or egg. Describe the colors you see. (spectrum)
3. Now focus the lights on a large sheet of white paper lying flat on the floor, so that the colors overlap in the center. Note the color white where the red, blue, and green light overlap. Ask: "What is white?" (sum of all colors)
4. Note where only two colors overlap. Describe the color you see. (red-green overlap = yellow light; red-blue overlap = magenta light; blue-green overlap = cyan)
5. Try to produce the same colors, using artists paints. Do you get the same colors when you mix pigments? (no)
6. Look through a prism to see the colors of the spectrum.
7. Ask: "How else might we see the spectrum?" (rainbow or looking through a drop of water)
8. Investigate the bending of light as it passes through a lens or water. (Look at half of a friend's face through a glass of water. What happened to the light? (different colors bent by different amounts and so they spread out to show their colors)

Extending the lesson:

1. What is the color green we see? (green pigment, which absorbs all the colors of white light except green)

NINTH GRADE, UNIT IV

2. What is black? (pigment which absorbs all white light)
3. What is white? (pigment which reflects light and absorbs none or very little color at all)
4. Investigate the reverse colors of a photographic negative.
5. Add to the class energy vocabulary list.

NINTH GRADE, UNIT IV

(Science, Geography,
Social Studies)

UNIT IV

2. Title: The Tides

Concept: The sun is the chief source of the earth's radiant energy.

Objective: To discover the relationship between total energy and the production of electricity

Introducing the lesson:

1. People of all ages have known of the power of the tides; only the French and Russians have succeeded in developing tidal power plants. Ask: "Why do you think there has been so much controversy about building tidal power plants?" (require a dam completely across a bay and very expensive)
2. Draw on the chalkboard a diagram of a tidal power plant: large bay, dam across the mouth, ocean outside.

Developing the lesson:

1. Draw arrows to show what happens at high tide (water flows through turbines in gates as it rushes into the closed bay)
2. Now show arrows to indicate flow at low tide (reversed flows out through turbines--now also reversed--to ocean)
3. Ask: "What happens when tides are changing?" (after high tide, gates closed to keep water in until ocean level lowers, then opened to turn generator again. After water flows out at low tide, gates closed until ocean rises again. This difference between levels in the ocean and the enclosed bay is called the "head of water")
4. Could tidal power plants be operated in Florida? (No, because they require tidal level differences of over 40 feet; there are only 15 locations in the world where tidal plants would be possible and only two of them are in the U.S., Passamaquoddy Bay in Maine and Cook Inlet in Alaska)
5. Investigate the construction of the French tidal power station in the LaRance estuary in Brittany, France which uses water from the English Channel.
6. What provisions have been made for ships to enter the port of San Malo? (locks for passage of ships)

Extending the lesson:

1. Investigate the disadvantages of tidal power. (dam across the bay; power lines; possible damage to marine life)

NINTH GRADE, UNIT IV

2. Discuss how rising costs of fossil fuels and demands for electricity may make tidal power plants economically feasible.
3. Environmentalists in New England have been protesting against a huge nuclear power plant in New Hampshire. Discuss relative values of nuclear and tidal power plants, assuming enough electricity to supply demand could be produced with tidal power.
4. Add to the class energy vocabulary list.

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UNIT IV

3. Title: Solar Electricity

Concept: The radiant energy of the sun can be used directly.

Objective: To discover the relationship between the sun's energy and its use for power

Introducing the lesson:

1. Without the development of solar cells for power, the space vehicles and satellites could not have been operated. What are solar cells? (tiny slices--wafers--of silicon, about $1\frac{1}{2}$ inches square and only a few thousandths of an inch thick)
2. Solar cells are called "photovoltaic cells". What does photovoltaic mean? (photo = light; voltaic = electricity; named after Alessandro Volta)

Developing the lesson:

1. How does a solar cell produce electricity? (the silicon wafer is coated with boron to produce a positive electric layer; this interacts with the negatively-charged silicon. When photons in sunlight strike the silicon cell, they are converted to electrons which flow to the boron layer, causing a flow of direct current (electricity))
2. Why are solar cells so expensive? (skilled hand labor in growing and cutting silicon crystals; more energy used to manufacture cells than they can produce)
3. Investigate development of the violet cell. (Clark, page 288)
4. Ask: "Is there any hope for solar cells for use in power plants?" (mass production of wafers from ribbons of silicon slices made in a machine looks promising)
5. Investigate proposals of Dr. Peter Glaser for development of solar power plants in space.
6. Why are environmentalists concerned about the Glaser proposal? (proposes to beam micro-wave electricity back to earth receiver; could act as a death ray?)

Extending the lesson:

1. Investigate possible development of solar power plants on earth. (for the immediate future, it looks like a choice of nuclear and coal for fuel, until the various solar technologies can be made economically feasible)
2. Ask: "Why would a solar cell power plant be more efficient in space?" (could be positioned to receive sun's rays)

NINTH GRADE, UNIT IV

24 hours a day; no loss of solar radiation by reflection from clouds and atmosphere)

3. Review the proposal for a solar farm. (lesson 1, Unit I)
4. Add to the class energy vocabulary list.

NINTH GRADE, UNIT V
(Social Studies)

UNIT V

1. Title: Changing Life Patterns

Concept: Life-styles of people are determined by their use of energy.

Objective: To discover the relationship between the life-styles of people and the amount of energy available for their use

Introducing the lesson:

1. Ask the students to list ways the energy shortage has affected their lives.
2. Make a class list of changes in life-style brought about by the energy shortage.

Developing the lesson:

1. On the basis of the class list, discuss which energy shortage or use seems to be the one most closely associated with their lives. (probably gasoline for the family automobile)
2. Discuss whether the energy shortage has really changed the standard of living of people. (only a change in wasteful habits such as driving to the store for a single item they forgot. U.S. living standards are still climbing - latest tallies for automobiles, appliances, furniture and other durable goods total \$1.35 trillion -- \$6238 for every person in the U.S. That's a 47% increase since 1970)
3. Ask the class to describe the American life-style. Are we greedy, selfish, lazy, thrifty, spoiled, whatever?
4. Discuss the relationship between life-style and standard of living. (how we live versus level at which you live - you may enjoy a high standard of living and be very frugal)
5. Is there a relationship between standard of living and energy use? (definitely, energy is the essential element)

Extending the lesson:

1. Go out and find examples of how people's use and the supply of energy affects their standard of living:
 - a. transportation - bicycle or gas guzzler?
 - b. diet - soup and crackers or steak?
 - c. life-style - in debt or saving?
 - d. occupations - unskilled or professional?

- e. recreation - rowboat or cabin cruiser?
- f. agriculture - family farm or agri-business?
- 2. Suggest ways to reduce use of energy in each example.
- 3. How do people's use of energy reflect their values?
- 4. Discuss the validity of the statement: "energy shortages cause changes in societies".
- 5. How about effect on individuals?
- 6. Has the energy shortage affected your community's standard of living? or only its habits?
- 7. Add to the class energy vocabulary list.

NINTH GRADE, UNIT V

(Home Economics, Social Studies,
Language Arts, Art)

UNIT V

2. Title: My Energy Use

Concept: People use energy to satisfy their needs.

Objective: To discover the relationship between energy use and
our daily lives

Introducing the lesson:

1. Ask each student to keep a list of things they did during a week which required energy.
2. For each activity listed, list the kind of energy used and the duration of the energy use; for example, electricity to toast bread - 2 minutes.
3. List the major categories of energy use for the class--food preparation, beauty, etc.

Developing the lesson:

1. Compare the total energy use by individuals in the class.
2. Why is there such a difference among individuals? (life-styles differ)
3. Find examples of energy use that seem unusual. (operated a laser beam, movie projector, etc.)
4. What do these tell us about the individual's use of energy? (using energy for more than needs)
5. Have each student use both the personal and class lists to design an individual energy conservation plan.
6. Put your energy conservation plan into action.

Extending the lesson:

1. Now make another one-week survey of energy use.
2. Was there any saving of energy as compared to the first survey?
3. Discuss what seems to be the best ways to save energy.
4. Draw pictures of your individual life-style before and after implementing your energy conservation plan.
5. Add to the class energy vocabulary list.

NINTH GRADE, UNIT V

(Social Studies, Science,
Geography)

UNIT V

3. Title: Developing Nations Want More

Concept: People need energy to raise their standard of living.

Objective: To discover the relationship between a nation's energy use and its standard of living

Introducing the lesson:

1. Review lesson 1, Unit II, on changing life patterns and the relationship between energy use and standard of living.
2. Find pictures of the "barrios" or slum communities on the outskirts of major Central and South American cities. (Caracas, Mexico City, Bogota, etc.)

Developing the lesson:

1. At the U.N. Conference on the Human Environment in Stockholm in 1972, the developing nations insisted on consideration of the problems of the poor in getting food, water, and their needs for life from the environment--not the pollution and energy problems of industrial nations. Discuss the worth of this proposal.
2. Ask: "Is this a valid concern?"
3. Delegates from poor nations said: "We would love to have your level of pollution and the good life it represents". Ask: "Why do the poor nations of the world equate energy use, pollution, industrial development, and the "good life?"
4. What should be the response of the U.S. delegate to the conference?
5. What was the response of the U.S. delegation? (the problems of people had to be discussed at "satellite meetings", not on the official agenda)
6. Ask: "Why should a hungry person be concerned about individual and national use of energy and pollution?"

Extending the lesson:

1. Discuss the validity of the claims of the developing nations to a greater share of the world's energy resources. (most of these resources are in underdeveloped nations. In the past, U.S. and European oil and mining companies have exploited these resources and kept these oil and mineral-rich nations poor)
2. How could this have happened? (nations with the resources did not have the technology to develop their own resources.

NINTH GRADE, UNIT V

Also, the small amounts paid for oil seemed like a lot to "poor" nations)

3. Discuss how the demands of the developing nations for a greater share of the energy (including dollars) are related to the energy "crisis".
4. Consider other contributing factors. (Middle East conflicts, international politics)
5. Add to the class energy vocabulary list.

NINTH GRADE, UNIT VI

(Social Studies)

UNIT VI

1. Title: Limits To Growth

Concept: Future energy supplies are limited because of present and past waste of resources.

Objective: To discover the relationship between past energy use and future energy supplies

Introducing the lesson:

1. In a controversial book published in 1972, "Limits To Growth", the Club of Rome named 5 factors that limit or determine growth of all kinds on the earth: population, industrial production, agriculture, natural resource development, and pollution. They warned that growth in each was doubling in short periods of time; for example, use of electricity is doubling every 7 years.
2. Ask: "Is there a limit to growth?" (yes, as all agree. But, there is considerable debate over how growth will end and when)

Developing the lesson:

1. Read the following French children's riddle, which concerns a pond, a farmer, and a water lily:
"The lily is doubling in size every day. In 30 days, it will cover the entire pond, killing all the creatures living in it. The farmer does not want that to happen; but being busy with other chores, he decides to postpone cutting back the plant until it covers half the pond. The question is: On what day will the lily cover half the pond? The answer is: On the 29th day--leaving the farmer only one day to save his pond".
2. Ask: "Are we now in our 29th day?" (during the gasoline shortages of 1973 and 1979, it looked that way)
3. What really determines the limits to growth? (energy. Every new discovery of an energy source has increased all five factors in the "Limits To Growth" study)
4. What happens when industrial output grows faster than population? (rising standard of living - more products for each person)
5. Discuss how this has affected the development of societies.
6. What happens if population doubles and agricultural production does not? (hungry people, as we now have)

Extending the lesson:

1. Consider how the five factors are related. (for example, we worried about pollution, so we redesigned engines and added emission control devices; this increased gasoline consumption and created a fuel shortage, which led to international political problems - all in a few years)
2. Have the class develop more chains of related events, such as medical advances or high-rise buildings.
3. What can we learn from these examples? (no one problem can be considered alone. Problems are all related and a change in any one affects all the others)
4. Do we want science and technology to remove all the limits to growth? (that is the question, even if they could)
5. Add to the class energy vocabulary list.

NINTH GRADE, UNIT VI

(Social Studies, Science,
Home Economics)

UNIT VI

2. Title: Peak Power

Concept: Power supply capacity is based on peak demand for electricity.

Objective: To discover the relationship between electric power production and people's demand for electricity

Introducing the lesson:

1. During a typical summer day in Florida, demand for electric power from the state's electric utilities at mid-afternoon and early evening is more than double the demand at 5:00 a.m. Ask: "What effect does this have on the generating capacity of Florida's electric power plants?" (they must plan to meet maximum demand)
2. What is "peak power"? (maximum demand made on a utility)

Developing the lesson:

1. Discuss why the demand for electricity would reach a peak at mid-afternoon or early evening. (air conditioners, cooking dinners, TV, etc.)
2. Discuss other times when peak power might be needed. (breakfast and hot shower time; TV prime time, etc.)
3. Discuss the effect of peak power demand on utility company planning. (must plan for maximum demand even if plant operates at only half capacity most of the time)
4. How does this affect the number and size of electric power plants? (need more or larger plants)
5. Consolidated Edison Company in New York City, in order to redistribute demand on the company facilities, has conducted an experiment to see what happens when customers are charged according to the time of day they use electricity. Under the plan, customers would pay 2½ times more for electricity during peak hours, less than average for use during off hours. Discuss the following questions:
 - a. How would this plan reduce the need for more generating capacity and hold down costs to customers?
 - b. What could you do to save electricity under such a plan?

- c. Would you use your washer, dryer, and dishwasher only during off hours to save electricity (money)?
- d. What problems would this plan involve? (metering would be difficult and expensive)

Extending the lesson:

- 1. Consider how you could save with appliances: their purchase, use, and maintenance. (efficiency)
- 2. Consider lights, water heaters, refrigerators, stoves.
- 3. Describe your life if you were limited to 1000 watts of electricity at any one time during the day. Which appliances would you use? Rate them according to your priorities.
- 4. Could you get by with fewer appliances?
- 5. Would you prefer an occasional blackout or brownout to having a new power plant built in your community?
- 6. Compare your list of appliances with those available to your parents when they were your age. Your grandparents.
- 7. Add to the class energy vocabulary list.

NINTH GRADE, UNIT VI
(Social Studies)

UNIT VI

3. Title: Locating Energy Industries

Concept: Everyone wants power plants for producing electricity, but not in their community.

Objective: To discover the relationship between people's values and locating new power plants

Introducing the lesson:

1. Discuss the following scenario: An electric utility company proposes the construction of a new generating plant in our community. It will be located on the river so the hot water from the plant (condensed steam) can be released into the river. The plant will be large enough to supply 1000 megawatts.
2. Ask for a class reaction to the proposal.

Developing the lesson:

1. Make a list of the advantages and disadvantages of this siting proposal.
2. Discuss the advantages (economy, jobs, etc.)
3. Discuss the disadvantages. (pollution, transmission lines, supply vehicles through town, etc.)
4. Investigate whether people in communities which encourage siting of utility plants there get lower rates for electricity. (no)
5. Should they?
6. Discuss whether the community reaction would be different if the proposed plant was to be nuclear fueled.
7. Compare the environmental problems of coal or nuclear fuel. Consider:
 - a. mining
 - b. transportation
 - c. use
 - d. waste disposal
8. Compare loss of life in coal-related and nuclear-related occupations. (both hazardous for miners)

Extending the lesson:

1. In 1950, the Atomic Energy Commission predicted that the development of nuclear power would produce electricity

that would be "too cheap to meter". Ask: "What happened to this prediction?"

2. Investigate how the public's fear of atomic energy as a result of the nuclear bombs has been exploited by the anti-nuclear lobby in the World.
3. Discuss the effect of the Three-Mile nuclear plant accident in Pennsylvania on the future development of nuclear power plants and their locations.
4. With oil in short supply, the nation faces a choice of coal or nuclear fuel for electric power plants. Which will it be?
5. Debate the issues.
6. Add to the class energy vocabulary list.

NINTH GRADE, UNIT VII

(Science, Social Studies, Art,
Language Arts, Health)

UNIT VII

1. Title: What Is Safe?

Concept: The search for energy, its use, and its wastes may cause undesirable environmental effects.

Objective: To discover the relationship between environmental quality and the disposal of the wastes of energy production and use

Introducing the lesson:

1. In the 1970 report of the Council on Environmental Quality, then President Richard Nixon said: "Unless we arrest the degradations that have been inflicted so carelessly on our natural systems--which exist in an intricate set of balances--we face the prospect of ecological disaster".
2. What did President Nixon mean by "degradations" and "ecological disaster"? (strip mining, oil spills, loss of environmental quality)

Developing the lesson:

1. Relate these remarks to the perceived and predicted results of the search for and use of energy.
2. Ask: "In terms of the waste products of our energy use, what is safe?" (How much pollution, radiation, etc. can the environment and people stand?)
3. Describe an environment fit for life and fit for living.
4. Discuss the validity of the following statement: "In our society, growth is made possible by the availability of cheap energy".
5. Investigate how we have lowered our national and state standards for air and water quality in order to provide cheap energy (lowered air pollution standards to allow burning of polluting high sulphur fuels in power plants)
6. Investigate the laws and regulations to increase mine safety and the health of miners.
7. Investigate problems of uranium miners and military personnel exposed to nuclear radiation in testing without safeguards or standards for exposure.
8. Investigate regulations designed to make safer the transportation of highly-explosive or harmful cargoes of trains and trucks, such as liquified natural gas - LNG.
9. Why are spills of liquified gases so dangerous? (when released from container they expand rapidly into flammable gases)

Extending the lesson:

1. Investigate the efforts to make automobile emissions "safer" for those who live in cities.
2. Draw a picture of yourself in a safe environment.
3. Describe your picture.
4. Discuss how one decides what is safe when the results of exposure to unsafe environments may not appear for years. (soldiers and miners exposed to radiation in nuclear mining and testing 40 years ago are only now being studied as their cancer rates rose dramatically)
5. Investigate the effects on people of:
 - a. mercury
 - b. lead
 - c. nuclear radiation
 - d. asbestos
 - e. chlorine gas
 - f. sulphur dioxide
 - g. carbon monoxide
 - h. others.
6. Add to the class energy vocabulary list.

NINTH GRADE, UNIT VII

(Social Studies, History,
Geography)

UNIT VII

2. Title: "Trade-Offs"

Concept: Living things are interdependent with their environment.

Objective: To discover the relationship between energy supply and use and the quality of the environment

Introducing the lesson:

1. One frequently reads about "trade-offs" to describe the apparent compromises made between environmentalists and developers, industrialists, etc. Ask: "What is a trade-off?" (I give up one of my demands if you will give up a demand of yours)
2. Make a list of trade-offs that have occurred in your community.

Developing the lesson:

1. Propose for discussion a situation in which an oil company wishes to explore for oil in the Ocala National Forest. Environmentalists try to stop the exploration on the grounds of destruction of timber and wildlife habitat.
2. Divide the class into two groups - environmentalists and oil company representatives.
3. Have the two groups choose a forest supervisor to arbitrate the discussion.
4. Have each of the groups meet to prepare their case for presentation. (pictures, speeches, charts, whatever)
5. Call a meeting of the two groups with the forest supervisor.
6. Let each group give its presentation.
7. Follow this with a question-answer period.
8. Let groups meet to discuss any compromises they might suggest or be willing to accept.
9. Let the company make their proposal for trade-off first, followed by the environmental group.
10. See if a trade-off can be arranged.

Extending the lesson:

1. What is the basic reality in a trade-off? (neither side is completely happy because they gave up something they wanted)
2. Investigate trade-offs in the construction of Disney World

and other major developments.

3. Investigate environmental battles that have been fought in Florida against industry expansion, power plant siting, Miami jetport, Cross-Florida Barge Canal, Everglades National Park water supply, etc.
4. Were there trade-offs in each of these?
5. Add to the class energy vocabulary list.

UNIT VII

3. Title: Energy And Civilization

Concept: Energy is an important element in the development of a civilization.

Objective: To discover the relationship between energy and the development of civilizations

Introducing the lesson:

1. Ask the students how the availability of energy has affected the development of our civilizations.
2. List the ways energy has influenced our development as a rich and powerful nation.

Developing the lesson:

1. Trace the influence on the development of civilizations of:
 - a. water wheel
 - b. windmill
 - c. sail
 - d. fire
 - e. plant breeding
 - f. steam engine
 - g. oil
 - h. slave labor
 - i. internal combustion engine
 - j. airplane
 - k. nuclear fission
2. Investigate the role of energy in the rise and fall of former civilizations.
3. Predict the role of energy in our civilization in the future.
4. List the possible new sources of energy or inventions which will enable us to continue the development of our civilization. (solar, nuclear fusion, etc. This could be a good review of all the proposals discussed in these energy lessons)

Extending the lesson:

1. Predict the effect on western civilization of the loss of any

of the following:

- a. a complete embargo on Arab oil supplies
 - b. refusal of Mexico to sell oil to the U.S.
 - c. a decision to ban the use of nuclear energy
 - d. replacement of fossil fuel energy with human energy
 - e. synthetic products
 - f. supplies of minerals (already critical)
 - g. mechanized agriculture
2. What are we to do to obtain enough energy just to carry on our basic way of life in the U.S.? (a good question!)
 3. Add to the class energy vocabulary list.

APPENDIXES

GLOSSARY

A Vocabulary of Energy Words - "ENERWORDS"

Ampere

A unit of measure for electric current.

Appliance

A device which does a special job, usually electric.

Barrel

A liquid measure of oil, usually crude oil, equal to 42 gallons or 306 pounds.

Bituminous Coal

Soft coal, high in volatile matter.

British Thermal Unit (BTU)

A unit of heat energy - the amount of heat necessary to raise the temperature of one pound of water one degree Fahrenheit.

Brownout

The lowering of power supplied to customers by a power company when power demand exceeds generating capacity.

Calorie

A unit of heat equal to the amount of heat necessary to raise the temperature of one kilogram of water one degree Celsius; equal to 1000 small calories.

Carbon Dioxide

A compound of carbon and oxygen formed when carbon or carbon materials are burned or used in the body.

Carbon Monoxide

A compound of carbon and oxygen formed when carbon or carbon materials are incompletely burned. When formed in automobiles, it becomes a major air pollutant.

Catalytic Converter

A device placed on the exhaust of an automobile that changes carbon monoxide and hydrocarbons which cause air pollution to carbon dioxide and water.

Centigrade

See Celsius.

Celsius

A temperature scale which runs from zero degrees (the temperature of melting ice) to one hundred degrees (the temperature of boiling water). Sometimes called Centigrade.

Charcoal

A porous, solid residue resulting from the incomplete combustion of wood or bone.

Chemical Energy

Energy stored in the structure of atoms and molecules, which can be released by a chemical reaction.

Clean Fuel

A low sulfur fuel.

Coal

A solid organic material formed by the decomposition of plant material without air, containing 75% carbon.

Coal Gas

"Fuel gas", the gas formed when coal is partially burned to make coke. Has one-third the energy of natural gas.

Coal Gasification

The process which converts coal to a gas.

Coal Liquification

The process which converts coal to a liquid fuel by the addition of hydrogen.

Coal Tar

A black, gummy substance produced when coal is distilled.

Coke

A porous, solid residue resulting from the incomplete combustion of coal heated in an oven with a limited supply of air. A good fuel, more nearly pure carbon than coal.

Combustion

Burning, a chemical reaction producing heat and light and, in some cases, a flame. Usually a combination of carbon and oxygen.

Conduction

The transmission of energy directly from one substance or molecule to another.

Conserve

To keep from being lost, wasted, or damaged.

Convection

The transfer of energy by moving masses of liquid or gasses.

Conversion

The process by which energy is changed from one form to another.

Cooling Tower

A structure for cooling waste water from power plants.

Cord

A measure of wood volume - a stack four feet by four feet by eight feet.

Cracking

The process of breaking down the molecular structure of heavy hydrocarbons into lighter hydrocarbons, as when gasoline is produced from crude oil.

Crude Oil

A mixture of hydrocarbons in liquid form found in underground reservoirs; the raw material from which most refined petroleum products are made.

Depletion Allowance

A tax exemption for a portion of the revenue received from producing a natural resource.

Dry Steam

Steam so hot it contains no water droplets.

Ecology

The study of relationships between living things and their environment.

Efficiency

The ratio of work or energy output to the energy input to do the work.

Electric Current

A flow of charged particles, usually electrons.

Electrons

Negatively charged particles that orbit the nucleus of an atom. A chemical reaction consists of the transfer and rearrangement of electrons between atoms.

Electrostatic Precipitator

A device that removes waste particles from the exhaust of power plants by attracting them to electrically-charged plates from which they can be washed away, thus preventing air pollution.

Energy

The ability to do work, to move a force a certain distance. It exists in many forms and can be converted from one form to another.

Energy Density

Energy per unit of weight in a fuel.

Energy Intensiveness

A measure of energy utilization; for example, the number of calories used to move a passenger one mile.

Environment

Everything that is not you - and you.

Environmental Impact Statement

A predicted analysis of the impact on the environment of a projected activity; for example, the mining of coal or offshore drilling for oil.

Fahrenheit

A temperature scale which uses 32 degrees as the melting point of ice and 212 degrees as the boiling point of water, named after its inventor.

First Law of Thermodynamics

The law of conservation of energy, which states that energy can neither be created nor destroyed.

Fission

The splitting of atoms (heavy nuclei) to release energy.

Food

The fuel used by animals, including man, to produce "body power".

Food Chain

The pathway over which any food material passes from the producing

organism to consuming organisms.

Force

The power exerted on an object to produce motion or change of direction.

Fossil Fuel

A natural fuel such as coal, oil, or natural gas, formed from the fossil remains of living things.

Fuel

A substance that can be burned to produce heat.

Fusion

The joining together of atoms to release energy.

Gasoline

A fuel composed primarily of light hydrocarbons, produced by "cracking" crude oil in a refinery.

Generator

A device which produces electric energy from mechanical energy, as in a motor or water turbine.

Geothermal Energy

Heat energy within the earth which produces steam when it comes in contact with water.

Geyser

A spring from which hot water and steam shoot into the air.

Greenhouse Effect

The warming effect of the carbon dioxide in the atmosphere which allows solar radiation to reach the earth but which absorbs (and keeps in) the heat radiation from the earth.

Harness

To control so as to use the power of, as of steam.

Heat

A form of kinetic energy resulting from the movement of molecules in matter. It flows from one body to another if there is a temperature difference between them.

Heat Engine

A device which converts heat energy into mechanical energy.

Heat Pump

A device which transfers heat from one place to another by using electric or mechanical energy. It can pump warm air into a building to heat it, or out of a building to cool it.

Heat Sink

Any substance that absorbs waste heat - air, water, or space.

Heat Tax

The heat energy that is lost when energy is converted from one form to another.

Horsepower

A unit of power equal to 746 watts.

Hydrocarbons

Molecules made up of hydrogen and carbon atoms in various proportions, usually formed by living things.

Hydroelectric Plant

An electric power plant in which electricity is generated by using the energy of falling water to turn turbines.

Indirect Energy

Any form of energy used to provide goods and services which themselves may or may not use energy.

Joule

A unit of energy or work; the amount produced by a force of one newton operating through the distance of one meter, named after its inventor.

Kerosene

A fuel used in jet engines and gas turbines, made up of a mixture of hydrocarbons by "cracking" crude oil in a refinery. Its hydrocarbons are heavier than those in gasoline or naphtha.

Kilowatt

A unit of electric power equal to 1000 watts.

Kilowatt-hour

A unit of energy or work equal to the use of one kilowatt of energy for one hour.

Kinetic Energy

The energy of motion; the ability of an object to do work because of its motion.

Laser

A device which can produce high intensity radiation by forcing the atoms or molecules in a material to radiate at the same time, rather than independently, as in a light bulb.

Light

Electromagnetic radiation which can affect the eye.

Light Water Reactor

A nuclear reactor in which water is the primary coolant, or moderator.

Liquified Natural Gas (LNG)

Natural gas that has been turned to a liquid by cooling it to minus 160 degrees Celsius, thus reducing its volume and making it easier and cheaper and probably more dangerous to store and ship.

Machine

A device which uses energy to do work.

Mechanical Energy

A form of energy which is seen as the motion of an object.

Megawatt

A unit of power equal to 1000 kilowatts or one million watts.

Moderator

The material (water, graphite, etc.) used in a nuclear reactor to control the rate of fission.

Natural Gas

A natural mixture of hydrocarbons found in porous rocks under the earth's surface, usually in association with petroleum. It is almost pure methane.

Non-renewable

Not able to be replaced once used up, as oil.

Nuclear Energy

Atomic energy, the energy released by changes in the nucleus of an atom in a reactor.

Nucleus

The dense, positively charged core of an atom.

Off-Peak Power

Power generated during a period of low demand.

Oil Shale

A sedimentary rock containing the material kerogen, which can be recovered as oil when the rock is heated at high temperatures.

Particulates

Small ash and soot particles produced in burning.

Peak Load

The maximum amount of power which a plant can produce in a given period of time.

Petrochemicals

Chemicals derived from petroleum.

Petroleum

An oily, flammable liquid mixture of hydrocarbons that may vary from almost colorless to black, found in sedimentary rocks and providing the raw material for a host of fuels and synthetic materials.

Photosynthesis

The process by which green plants convert the radiant energy of the sun into chemical potential energy when carbon dioxide and water are converted into carbohydrates.

Photovoltaic Process

The process by which radiant energy is converted directly into electric energy.

Pollution

Contamination or fouling of land, air, or water by chemicals, heat, noise, atomic radiation, or wastes.

Potential Energy

Stored energy as in a battery or water behind a dam.

Power

The rate at which energy is used or work is done, measured in units of energy per unit of time (calories per second) or in units such as Kilowatts or Horsepower.

Primary Energy

Energy in its natural form, such as coal or oil, before its conversion to end-use forms of energy, such as heat or electricity.

Radiation

The emission of energy through matter or space.

Reserves

Portions of a resource such as oil which have been discovered and can be extracted by available technology.

Resource

↑ A product of nature which people use to satisfy their needs, wants, and dreams.

Second Law of Thermodynamics

In any energy conversion, some energy passed from a useful to a less useful form, usually lost heat or "heat tax".

Smog

An atmospheric condition in which the air is polluted by smoke, fog, sulphur and nitrous oxides. Sulphur oxides react with water to form sulphuric acid droplets, which fall as "acid rain", causing great damage to marble and limestone buildings and statues and to bodies of water which become too acid to support living things.

Solar Cell

A device which converts solar radiant energy directly into electric energy by the photovoltaic process.

Solar Collector

A device for collecting solar energy and converting it into heat.

Solar Energy

The electromagnetic radiation transmitted by the sun. The earth receives about 4,000 trillion kilowatt-hours per day.

Synthetic Natural Gas (SNG)

A gaseous fuel manufactured from coal, containing almost pure methane.

Tar Sand

A sandy geologic deposit in which oil is found.

Temperature

The "hotness" or "coldness" of a substance.

Thermal Pollution

Any increase in air or water temperature by waste heat from electric generating plants which causes disturbances in the ecology of an area.

Turbine

A motor turned by a powerful stream of water or gas.

Uranium

A radioactive, metallic element used as a fuel in nuclear power plant reactors to generate electricity.

Utility

A company which provides services for people such as gas, oil, or electricity.

Volt

The electromotive force which will cause a current of one ampere to flow through a resistance of one ohm.

Watt

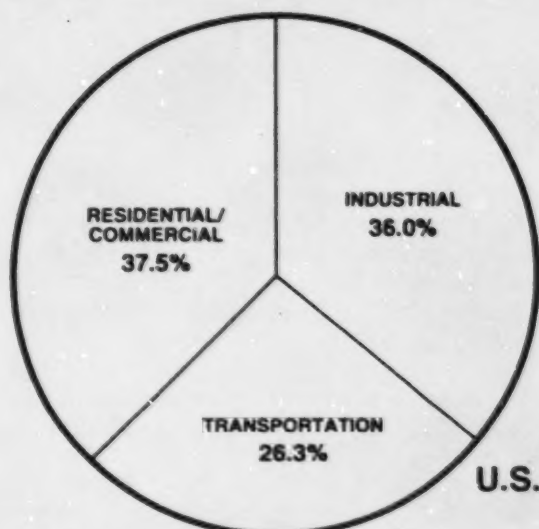
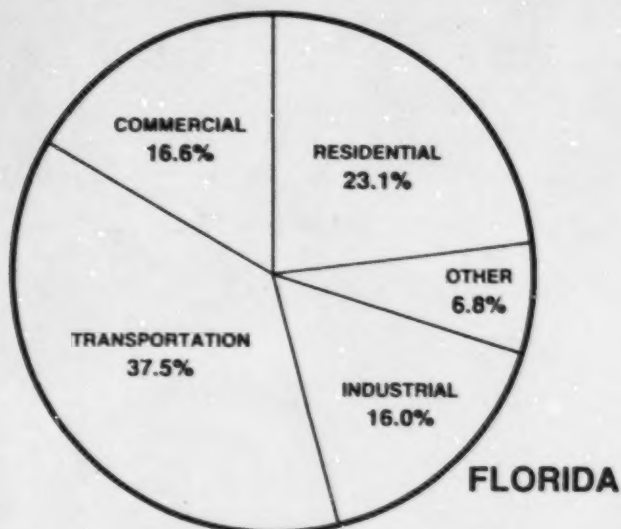
A metric unit of power used in electric measurements of the rate at which work is done or energy used. One watt equals one Joule of work per second.

Work

The product of a force times the distance the force is applied or the object is moved.

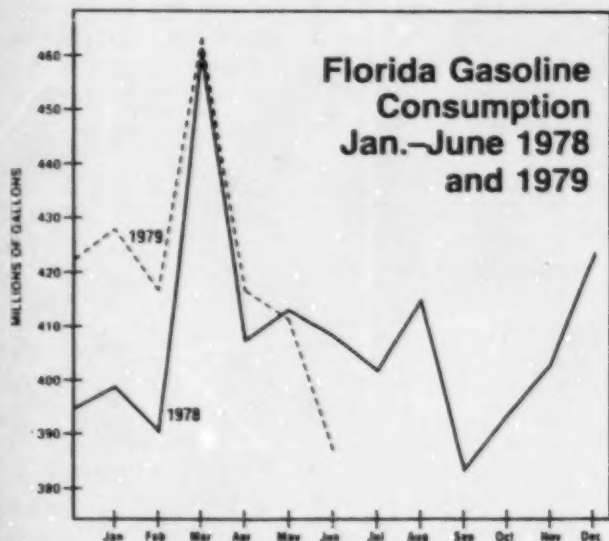
FLORIDA ENERGY PROFILES

Total Energy Consumption by Sector, Florida and the United States, 1978



Transportation is the largest energy-consuming sector of the Florida economy. The industrial sector and the commercial sector each consume only half as much energy as transportation, while the residential sector consumes only 60 percent as much. In contrast, the

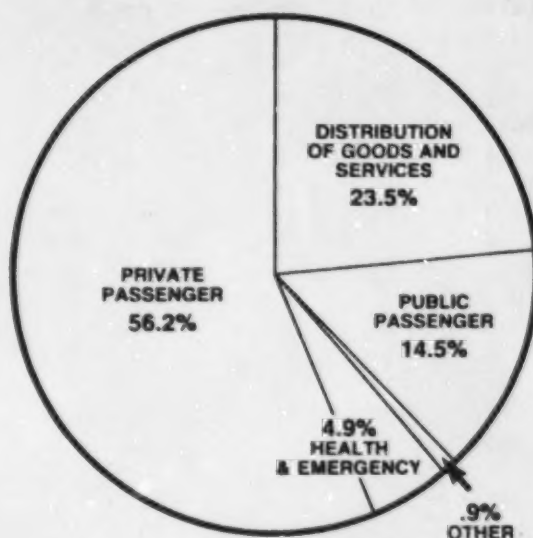
industrial sector is the largest energy consumer of the U.S. economy. Florida is, therefore, relatively more dependent on gasoline than is the nation in general. Factors contributing to this include Florida's large land area, land use patterns, and high degree of travel activity.



During the early months of 1979 gasoline consumption in Florida was greater than during the previous year, although the effects of supply constraints became apparent by March 1979. Easter holiday was celebrated in March 1978 and April 1979 thus holiday traffic sustained a higher level of gasoline consumption during April 1979 than the year before.

In May of 1979, gasoline consumption declined sharply and, for the first time, fell below the corresponding 1978 month's consumption. June 1979 consumption showed an even sharper decline, and consumption was 5.1 percent below that of June 1978.

Energy Consumed in Transportation in Florida, 1976



More than half of all energy consumed for transportation in Florida fuels private passenger vehicles. Less than one-fourth of transportation energy consumption is devoted to distribution of goods and services primarily via truck and rail. The bulk of public passenger transport in Florida represents airline traffic; buses account for only .07 percent of petroleum use in the transportation sector.

ENERGY FACTS 1978

Overview

Energy consumption and production data for 1978 are available and they indicate some changes in the U.S. energy consumption patterns. Overall domestic energy consumption increased from 76.6 QBtu in 1977 to 78.0 QBtu in 1978. This reflects an increase of 1.9% over 1977.

The distribution of this consumption has changed. In 1977, residential consumption accounted for 37.1% of the total U.S. energy consumption. In 1978, this figure increased to 37.6%. The transportation sector increased its share of the total, from 26.2% in 1977 to 26.4% in 1978. However, the industrial sector's percentage of the total decreased from 36.7 in 1977 to 36.1 in 1978.

When examining the total energy consumption figure by fuel, it can be noted that petroleum consumption as a percentage of the total, is down .1% from 1977, natural gas is down by .4% and coal is down by .4% (affected by 5% decline in production due to coal miners' strike).

On the other hand, hydropower and nuclear make up a larger percentage of the total consumption figure for 1978 than they did in 1977 (up .7 and .3 respectively). This is a result of increased levels of production in both areas. Petroleum imports decreased from 18.8 QBtu to 17.4 QBtu in 1978.

Total Energy	QBtu*	EJ**
Production	61.0	64.7
Consumption	78.0	82.7
Imports	18.9	20.0
Exports	2.0	2.1

Information from: Energy and Education
May, 1979
NSTA Newsletter

Consumption Patterns

By economic sector	Percent
Residential/Commercial.....	37.6
Industrial.....	36.1
Transportation	26.4

By fuel

Petroleum.....	48.4
Natural Gas.....	25.4
Coal.....	18.1
Hydropower.....	4.0
Nuclear.....	3.8
Other.....	0.1

Supply and Demand

	QBtu*	EJ**	Natural Amounts
Coal			
Consumption	14.1	14.9	623.4X10 ⁶ tons
Production	15.1	16.0	660.3X10 ⁶ tons
Imports	.08	.08	3.0X10 ⁶ tons
Exports	1.1	1.2	40.7X10 ⁶ tons
Oil			
Consumption	37.8	40.1	6.84X10 ⁹ bbls
Production	21.7	23.0	3.74X10 ⁹ bbls
Imports	17.4	18.4	2.99X10 ⁹ bbls
Exports	.7	.7	.12X10 ⁹ bbls
Natural Gas			
Consumption	19.8	21.0	19.4X10 ¹² ft ³
Production	19.3	20.4	18.9X10 ¹² ft ³
Imports	1.0	1.0	.95X10 ¹² ft ³
Hydroelectric			
Production	2.9	3.1	280.8X10 ⁹ Kwh
Nuclear Electric			
Production	3.0	3.2	276.4X10 ⁹ Kwh
Geothermal and Other Electric			
Production	.1	.1	3.3X10 ⁹ Kwh

*Q = Btu X 10¹⁵

**EJ = Joule X 10¹⁸

ENERGY QUICKIES

By
David E. LaHart
Florida Solar Energy Center

Energy Laws

Energy cannot be created or destroyed.

Energy can be changed from one form to another but at each change, there is a significant loss of energy. All energy becomes heat radiated into the environment.

Consumption

Americans use about 1/3 of the world's energy but represent six percent of the world's population. In 1978, we used 78 quads (quadrillion BTU is 10¹⁵). One quad is equal to the amount of gasoline used by 12 million cars in one year.

Petroleum

In 1978, the U.S. consumed an average of 18.7 million barrels of oil per day (785.4 million gallons). Of this, 8.2 million barrels (44 percent) was imported oil.

Floridians used an average of 574 gallons of gasoline in 1978; the national average was 532 gallons. Florida's rate of gas consumption is 12 million gallons per day.

Electricity

Electrical generating plants take three units of fuel and produce two units of heat and one unit of electricity.

Electricity is usually measured in watts and time. (Kilowatt = 1,000 watts)

Kilowatt/hour = 100-watt light bulb burning for ten hours. The average Florida household uses 1,000 kwh each month.

It takes about one pound of coal to produce one kwh of electricity so it takes about 1,000 pounds of coal to produce the electricity for each Florida household each month (six tons per year).

Electricial Generating Plants

10 mw (million watts) produces enough electricity for 3,000 people.

1,000 mw plant produces enough electricity for a city of 350,000. This is a common size for a nuclear plant.

Solar Energy

The solar radiation that falls on 1/2 of one percent of the land area in the United States is equal to our total projected energy demand in

2000. Unfortunately, land plants collect this energy at less than one percent efficiency. Total U.S. biomass fixation is about five million tons per year and (at 7,500 BTU's per pound) is equal to 75 quads.

It would take 912 square miles of southern forest to provide the fuel for a 1,000 mw electrical plant at 80 percent load and 33 percent efficiency.

SUGGESTED READINGS

- Clark, Wilson, Energy for Survival, Anchor Press, New York, (paper), 1975. Every teacher should have this book, which covers every aspect of energy use by people since early times; both general and technical; from science to wars; from early civilization to the future.
- Daniels, Farrington, Direct Use of the Sun's Energy, Ballantine Books, New York, New York, 1975.
- Halacy, D. S., The Coming Age of Solar Energy, Avon, New York, 1973.
- Knox, Susan, The Energy Crisis Survival Kit, Manor Books, New York, 1974.
- Lefkowitz, R. J., Fuel for Today and Tomorrow, Parents Magazine Enterprises, New York, New York, 10017, 1974.
- Meadows, D., et. al., The Limits to Growth, Universe Press, New York, 1972.
- Meinel, Aden and Marjorie, Power for the People, private publication, 1970.
- Mother Earth News, Handbook of Homemade Power, Bantam, New York, 1974.
- Singh, Ram Bux, Biogas Plan, Mother Earth News, Post Office Box 70, Hendersonville, North Carolina, 28739.
- Stoner, Carol, Editor, Producing Your Own Power, Vintage, New York, New York, 1974.
- Wilson, Michael, and the Editors of Life, Energy, Time-Life Books, Life Science Library, New York, New York, 1970.

SOURCES OF ENERGY EDUCATION INFORMATION

ENERGY EDUCATION MATERIALS

Governor's Energy Office
The Capitol
Tallahassee, Florida 32301

Office of Environmental Education
Department of Education
Knott Building
Tallahassee, Florida 32301

Technical Information Center
Consumer Service Branch
Department of Energy
Post Office Box 62
Oak Ridge, Tennessee 37830

LOCAL SOURCES

School District Contact Person for Energy Education
Your Utility Company
Environmental Centers

GENERAL INFORMATION

Governor's Energy Office
The Capitol
Tallahassee, Florida 32301

Technical Information Center
Consumer Service Branch
Department of Energy
Post Office Box 62
Oak Ridge, Tennessee 37830

Environmental Protection Agency
Washington, D. C. 20240

LOCAL SOURCES

County Cooperative Extension Office
Your Utility Company
Newspapers, including Business Section

GOVERNOR'S ENERGY OFFICE

DOCUMENTS

1. AN ANALYSIS OF SOLAR WATER HEATING INSTALLATIONS IN STATE BUILDINGS. (1976)

A study done for the Governor's Energy Office by Dr. Ronald D. Evans, Mechanical Engineering and Aerospace Sciences, and Dr. Robert D. Doering, Industrial Engineering and Management Systems, Florida Technological University. (STAR 76-021)

2. ANNUAL REPORT TO THE LEGISLATURE: 1978. (February, 1979)

3. ANNUAL REPORT TO THE LEGISLATURE: 1977-78. (May, 1978)

4. BASES FOR DEVELOPMENT OF A VIABLE ENERGY CONSERVATION POLICY FOR FLORIDA RESIDENTS. (1976)

A study done for the Governor's Energy Office by Dr. Jack E. Steen, Dr. William A. Shrode, and Edwin J. Stuart, College of Business, Florida State University.

5. ENERGY MANAGEMENT SYSTEMS FOR STATE BUILDINGS. (December, 1978)

A study done for the Governor's Energy Office by the College of Engineering, Florida Technological University, (STAR 77-70230)

6. FLORIDA ENERGY 2000 A.D.: HOW DO WE GET THERE FROM HERE? (Proceedings of a conference held January 11, 1978)

7. FLORIDA ENERGY RESOURCES. (1978)

8. FLORIDA NATURAL GAS SITUATION, HEATING SEASON: NOVEMBER 1978-MARCH 1979

9. FLORIDA'S ENERGY EMERGENCY CONTINGENCY PLAN (DRAFT). (November, 1978)

10. FORECASTS OF ENERGY CONSUMPTION IN FLORIDA. (June, 1978)

11. HEAT RECOVERY TECHNIQUES AND DEMAND MONITORING OF HOT WATER SYSTEMS IN STATE BUILDINGS. (December, 1978)

A study done for the Governor's Energy Office by Dr. Ronald D. Evans, Mechanical Engineering and Aerospace Sciences, Dr. Robert D. Doering, Industrial Engineering and Management Systems, and Professor James K. Beck, Mechanical Engineering and Aerospace Sciences, Florida Technological University. (STAR 77-021)

12. MODEL ENERGY EFFICIENCY BUILDING CODE: CODE FOR ENERGY CONSERVATION IN NEW BUILDING CONSTRUCTION WITH FLORIDA AMENDMENTS. (November, 1978)

Prepared by the consulting engineering firm of Brabham, Kuhns, DeBay under a contract from the Governor's Energy Office.

A set of explanatory notes and tables to accompany the model code is also available.

13. MONTHLY FLORIDA MOTOR GASOLINE CONSUMPTION: 1970-1978. (June, 1979)
14. PATTERNS OF ENERGY CONSUMPTION IN FLORIDA: 1973-1975. (July, 1978)
- Prepared for the Governor's Energy Office by the Energy
Patterns Study Group, College of Business, Florida State
University. (STAR 76-2025)
15. PATTERNS OF ENERGY CONSUMPTION IN FLORIDA: 1976. (January, 1979)
- Prepared for the Governor's Energy Office by the Energy
Patterns Study Group, College of Business, Florida State
University. (STAR 77-2024)
16. A PLANNER'S HANDBOOK ON ENERGY (WITH EMPHASIS ON RESIDENTIAL USES).
(November, 1975)
17. STATISTICS OF THE FLORIDA ELECTRIC UTILITY INDUSTRY: 1960-1976.
(May, 1978)

REVIEW SHEET (7-9)

This teachers' guide, "Energy and My Environment," (7-9) is printed this first time in DRAFT form for your review, field testing and comments. Your evaluation of these lessons will be sincerely appreciated and your suggestions considered for inclusion in our final publication.

Sections of Guide Taught

Grade ____ Unit ____ Lesson ____ Grade ____ Unit ____ Lesson ____

Grade ____ Unit ____ Lesson ____ Grade ____ Unit ____ Lesson ____

Grade ____ Unit ____ Lesson ____ Grade ____ Unit ____ Lesson ____

Are lessons appropriate for grade level? _____

Describe reaction of students. _____

Is there sufficient emphasis on teaching energy facts? _____

Is there sufficient emphasis on teaching values? _____

Your ideas for extending the lessons:

Grade ____ Unit ____ Lesson ____

Grade ____ Unit ____ Lesson ____

Grade ____ Unit ____ Lesson ____

Please put additional ideas on back of review sheet; include the grade, unit and lesson numbers.

Other comments and suggestions: _____

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Reviewer: _____

Title or Position:

Address:

School: _____ County: _____

Phone Number: ()

Return this review sheet to: Rosalyn B. Tillis
Energy Education Coordinator
Governor's Energy Office
The Capitol
Tallahassee, Florida 32301

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Grade ____ Unit ____ Lesson ____ Grade ____ Unit ____ Lesson ____

Are lessons appropriate for grade level? _____

Describe reaction of students. _____

Is there sufficient emphasis on teaching energy facts? _____

Is there sufficient emphasis on teaching values? _____

Your ideas for extending the lessons:

Grade ____ Unit ____ Lesson ____

Grade ____ Unit ____ Lesson ____

Grade ____ Unit ____ Lesson ____

Please put additional ideas on back of review sheet; include the grade, unit and lesson numbers.

Other comments and suggestions: _____

Reviewer: _____

Title or Position: _____

Address: _____

School: _____ County: _____

Phone Number: () _____

Return this review sheet to: Rosalyn B. Tillis
Energy Education Coordinator
Governor's Energy Office
The Capitol
Tallahassee, Florida 32301